The Journal of MENA Sciences

ISSN 2412- 9763 (Print)
ISSN 2412-8937 (Online)

Vol. 2, No. 4
April, 2016

THE JOURNAL OF MIDDLE EAST AND NORTH AFRICA SCIENCES

Editorial Board

Table of Contents

Bio-ethanol Production from Spent Grain and its Various Applications: An Overview

J. T. Oladeji[1*] • A. O. Alade[2] • S. A. Popoola[3] • A. D. Ogunsola[4]

[1, 3, 4] Department of Mechanical Engineering, Faculty of Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[2]Department of Chemical Engineering, Faculty of Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
jtoladeji@lautech.edu.ng

Abstract: The challenge to find and develop alternative sources of energy so that our decreasing reserves of crude oil and other fossil fuels may be conserved is of concern. However, this energy source must not interfere nor compete with human means of survival. The brewery industries generate a large amount of waste with a spent grain (SG) being the major one, which is currently under-utilized and usually disposed off indiscriminately. This has raised environmental concern. However, spent grain is a rich source of lignocellulose, which can be converted through hydrolysis and fermentation to bio-ethanol and this can be used as pure or blended fuel for automobile and heating purposes. The aim of this article is to review the composition, applications and other uses of brewer's spent grain (SG). The full utilization of existing technology and the promise of new development were also examined in this review. Also reviewed were works of few researchers who had worked on brewer's spent grain. This study concluded that spent grain though a waste product can be used to generate energy in form of ethanol production and that the quantity of ethanol that can be produced from spent grains depends on the quantity of reducing sugar and residual starch content. The higher the reducing sugar and residual starch content the higher the quantity of ethanol that can be extracted. Thus, spent grain is a potential biomass for the production of bio-fuel particularly in developing nations.

To cite this article
[Oladeji, J. T., Alade, A. O., Popoola, S. A., & Ogunsola, A. D. (2016). Bio-ethanol Production from Spent Grain and its Various Applications: An Overview. *The Journal of Middle East and North Africa Sciences*, 2(4), 1-9]. (p-ISSN 2412- 9763) - (e-ISSN 2412-8937).http://www.jomenas.org. **1**

Keywords: Bio-ethanol; bio-fuel; biomass; fermentation; spent grain.

1. Introduction

The main raw materials for industrial ethanol production are corn and sugarcane and it is expected that there will be a limit to the supply of these raw materials in the nearest future. This is because; the use of these crops for production of ethanol competes directly with their use as food sources (Pokhrel et al., 2008). Non-food feed stocks rich in fermentable carbohydrates are therefore of interest, particularly spent grain (SG), which consists of residues remaining after starch extraction. They are low valued products and are currently processed as an animal feed or disposed of as wastes (Mussatto et al., 2006).

However, they are a rich source of lignocelluloses, which may be converted to fermentable sugars for the production of bio-ethanol and can be blended with petrol or used as a pure fuel in certain engines (examples are flexi vehicles which are not available at the moment in West Africa).The advantages of using spent grain (SG) as a raw material for ethanol production is that it is abundant and can be gotten at a little or no cost, which makes it relatively cheaper than those gotten from sugar or starch based feed stocks.

There is resurgence in the research of bio-fuels, which is not in response to a single driving force, but to four independent forces. These forces are the need to develop a domestic fuel, a renewable fuel, a fuel which does not add net carbon to the atmosphere and a fuel that does not compete with food. At this present age, there is a need for pollution reduction especially those from industrial activities. This has become a global concern and both developed and underdeveloped countries are trying to adapt to this by modifying their processes especially most large companies no longer consider residues as waste, but recycles it as a raw material for other processes (Duru et al., 2003).

To meet the increasing demand for alternative bio-fuels, other bio-ethanol sources, asides those used for food or requiring large changes in land act needs to be exploited. Waste lignocelluloses bio-ethanol

from food processing such as spent grains (SG) from breweries has been identified as a potential bio-mass source for bio-ethanol production by microorganisms; which represents renewable supplies of fermentable sugars. Therefore, the world will have a lesser problem if every nation can produce her fuel by the processing and fermentation of lignocellulose rich bio-mass (spent grain) as a potential source of sugar for fuel ethanol (Kim et al., 2004).

2. Brewer's Spent Grain (SG): A Bye-Product of the Brewing Industry:

Brewers' spent grains (SG) are a major product of the brewing process and is generated at a rate of up to 30% of the weight of the initial malt grist (Aliyu and Bala, 2011). SG generated worldwide has been estimated at around 30 billion kilograms per annum (Mussato, 2009; Olugbenga and Ibileke, 2011).

Traditionally, these materials had either been discarded or sold as animal feed. However, these days, brewing industries are seeking to find added-value applications, which change traditional views of "waste" streams and reclassify them as "co-products". There has been a substantial amount of research published in recent years targeted at finding novel and more profitable or energy efficient use for SG.

Brewer's grains are a heterogeneous mixture of grain remnants from which the soluble and mast digestible components of malt have been extracted. SGs at source are typically 70-85% moisture (Aliyu and Bala, 2011). At these levels, spoilage due to mold growth, for example, can occur within five to seven days in warm climates. An efficient washing process will digest practically all of the starch in malt together with some protein fractions, as well as stabilizing many low molecular weight compounds and soluble gums. The remaining material is enriched in soluble lignin and cellulosic materials. However, the relatively high protein and carbohydrate contents of SG both augur well for its functional properties so long as adequate and cost-effective strategies for processing the material can be developed.

3.Generation of SG in Brewing Operation:

Brewer's spent grain (SG) is the main by-product of the brewing industry, representing approximately 85% of total by-products generated and it is rich in cellulose non-cellulosic polysaccharides and has a strong potential to be recycled (Aliyu and Bala, 2011). Spent grains are also the residue remaining after the extraction of wort. This lingo-cellulose rich biomass provides a source of sugar for bio-ethanol fermentations.

The composition of brewer's spent grain as described in the literature contains primarily grain husks and other residual compounds such as hemicelluloses, cellulose and lignin (Kanauchi, et al., 2001; Russ et al., 2005; Mussatto and Roberto, 2006; Mussatto et al, 2008a). All these contents make the spent grain a good feedstock for ethanol production.

Brewers' spent grain has high nutrients value (Tang, et al., 2009), and contain cellulose, hemicelluloses, lignin, and high protein content as shown in Table 1. The more distinct monosaccharide available in SG are xylose, glucose, and arabinose (Mussatto, 2009). However, the variation in its component percentage composition can be due to the variety of the grains used, harvest time, malting and mashing conditions, method of preservation and also the quality and type of adjuncts used during the process (Robertson, et al., 2010).

Table 1: *Chemical composition of brewers' spent grain (SG) as reported in the literature.*

Components (% dry weight)	Kanauchi etal. (2001)	Russ et al. (2005)	Mussatto and Roberto (2006)	Mussatto etal. (2008a)	Adeniran etal. (2008)	Khidzir etal. (2010)
Cellulose	25.4	23-25	16.8	16.8±0.8	-	-
Hemicelluloses	-	30-35	28.4	28.4 ±2.0	-	-
Lignin	11.9	7.0-8	27.8	27.8 ±0.3	-	-
Proteins	24	19-23	15.3	-	2.4 ±0.2	6.4±0.3
Ashes	2.4	4-4.5	4.6	4.6 ±0.2	7.9 ±0.1	2.3±0.8
Extractives	-	-	5.8	-	-	-
Others	21.8	-	-	22.4 ±1.2	-	-
Carbohydrates	-	-	-	-	79.9±0.6	-
Crude fibre	-	-	-	-	3.3±0.1	-
Moisture contents	-	-	-	-	6.4±0.2	-
Lipid	10.6	-	-	-	-	2.5±0.1
Acid detergent fibre	-	-	-	-	-	23.3
Total Carbon (%)	-	-	-	-	-	35.6±0.3
Total Nitrogen (%)	-	-	-	-	-	1.025±0.05

4.Preservation Techniques of SG:

Several methods have been proposed to prolong brewer's spent grain (SG) storage time as a result of its high moisture content. Factory drying has been the most effective method of preserving SG. However, owing to the growing global concern over high energy cost, many breweries, especially those in the developing countries can no longer afford this practice (Ikurior, 1995).

The advantage of drying as a preservation method is that it reduces the product volume, and decreases the transport and storage costs. Many breweries have plants for SG processing using two-step drying technique, where the water content is first reduced to less than 60% by pressing, followed by drying to ensure the moisture content is below 10% (Santos et al., 2003). However, the traditional process for drying SG is based on the use of direct rotary-drum

driers. This procedure is considered to be energy-intensive.

Bartolome´ et al. (2002) studied the effects of SG preservation using freeze-drying, oven drying and freezing methods. Their findings showed that preservation by oven drying or freeze-drying reduces the volume of the product and does not alter its composition while freezing is inappropriate as it affects the composition of some sugars such as arabinose. But overall, freeze-drying is economically not feasible on the large scale; making the oven-drying to be the preferred method. Thin-layer drying using superheated steam was proposed by (Tang et al., 2005) as an alternative method. The circulation of superheated steam occurred in a closed-loop system; this reduces the energy wastage that occurs with hot-air drying. Also, the exhaust steam produced from the evaporation of moisture from the SG can be used in other operations. Thus, the superheated steam method has several advantages including the reduction in the environmental impact, an improvement in drying efficiency, the elimination of fire or explosion risk, and a recovery of valuable volatile organic compounds. Another method is the use of membrane filter press. In this process, SG is mixed with water and filtered at a feed pressure of 3 to 5 bar, washed with hot water (65°C), membrane-filtered and vacuum-dried to reach moisture levels of between 20 and 30% (El-Shafey et al., 2004). Moreover, chemical preservatives such as lactic, formic, acetic, benzoic acid and potassium sorbate can effectively be used for preserving the quality and nutritional value of SG as reported by Al-Hadithi et al. (1985).

5. Previous Works on Bio-Ethanol Production from Spent Grain (SG):

White et al., (2008) studied bio-conversion of brewers spent grain to bio-ethanol and P. stipitis strain was selected based on its superior performance compared with several xylose-utilizing strains (Candida, Cryptococcus, Kluyveromyces, Pichia and Pachysolen species). The K. marxianus strain was also included as it showed excellent activity on glucose and also known to utilize xylose (Yablochkova, et al., 2003) and due to its high temperature tolerance (Hughes. et al., 1994).

Also, in preliminary experiments, this strain performed better than a distilling strain of S. cerevisiae on glucose synthetic media. Hydrolysate was prepared from 20% SG, pretreated with 0.16N HNO3, partially neutralized to pH 5–6 and digested with enzymes for 18 h, contained 27g/l glucose, 16.7g/l xylose and 11.9g/l arabinose. P. stipitis and K. marxianus produced 8.3 and 5.9g/l ethanol respectively from a hydrolysate containing 66.6 g RS/l.

Yohannan et al., (2010) worked on the conversion of SG from malted barley, sourced from malt whisky distillery and from an ale brewery spent grain to ethanol by acid/enzyme hydrolysis and the fermentation by K. marxianus and P. stipitis was examined. Dried and hammer milled SG (20% w/v) was hydrolysed with 0.16 N HNO3 by autoclaving at 121ºC for 15 minutes after which the pH was adjusted to pH 5-6 by stepwise addition of 10 M NaOH and inoculated with P. stipitis or K. marxianus from 48 h cultures.

Fermentation by K. marxianus for 48 h produced 14.8 and 7.5 g/l ethanol from BSG and GSG hydrolysate respectively while fermentation by P. stipitis produces 13.3g/l and 9.1g/l for BSG and GSG respectively. The conversion of SG hydrolysates from brewer's malt and maize distiller's SG is compared. The highest ethanol yields were obtained for the brewing SG, with 14.8 and 13.3g/l produced by K. marxianus and P. stipitis fermentation, respectively.

This may be due to higher residual starch content of the BSG which would alter the glucose level of the SG hydrolysate, resulting in greater ethanol concentrations from fermentation of the brewer's SG compared to that from distiller's and also the differences in composition of the SGs which depends on the operational conditions used during mashing to extract the starch. The reduced ethanol yields in the study of White et al., 2008 may be due to the lower RS (reducing sugar) content of the hydrolysate. The hydrolysate had 66.6 g/l RS compared to 78 g/l for the BSG hydrolysate in the study of (Yohannan, et al., 2010).

Olugbenga, et al., (2011) also studied bio-ethanol production from brewers spent grain where the sample was hydrolysed with 1.25w/v H2SO4 in autoclave at 121˚Cfor 17minutes and the pH of the sample was adjusted with 0.5 M NaOH, from 4.2 to 5.0 after this, the inoculums S. cerevisiae was added and the fermentation was carried out for 7 days. The alcohol content of the fermented mash after the seventh day was 1.9%. The result of this study shows that the rate of alcohol production through fermentation of industrial waste (spent grain) by baker's yeast (S. cerevisiae) increases with fermentation time. The finding of this work suggests that bio-ethanol can be produced from brewer's spent grain that has been pretreated with acid and in addition to this the quantity of bio-ethanol produced is directly proportion to the amount of total carbohydrate and reducing sugar available in the samples and inversely proportion to the fiber content of the sample.

Table 2: *Summary of previous works by various authors.*

Author	Topic	Inoculums	Hydrolysis	Ethanol Yield (g/l)	Ethanol Content (%)
Olugbenga et al., 2011	Bio-ethanol production from brewers spent grain	S. Cerevisiae	Acid treated	NA	1.9
Yohannan et al., 2010	Brewer's spent grains (BSG) a substrate for bio-ethanol	K. Marxianus	Acid/ enzyme	14.8	NA
		P. Stipitis		13.3g/l	
	Maize distiller's spent grains (GSG) a substrate for bio-ethanol	K. Marxianus	Acid/ Enzyme	7.5g/l	
		P. Stipitis		9.1g/l	
White et al., 2008	Bioconversion of brewers spent grain to bio-ethanol	K. Marxianus		5.9g/l	NA
		P. Stipitis		8.3g/l	
Erdelji, 2007	Bio-ethanol from brewers and distillers spent grain	P. Tannophilus	Acid hydrolysis	NA	0.3
		P. Stipitis			0.15
		C. Tennuis			0.008
		Cry. Albidus			0

NA = Not available

6. Applications of Brewers Spent Grain (SG):

There are many applications of SG as highlighted in sections 6.1-6.2

6.1 Brewers Spent Grain as Animal Waste:

Brewers' grains have traditionally been used by farmers for feeding animals because of the presence of cellulose, hemicellulose and lignin, and also the amount of readily available substances such as sugars, protein content (circa 18% of dry matter) and amino acids which are of nutritional value helps in its usage as feed for ruminants (Bisaria et al., 1997).

But there are other numerous potential alternative uses, some now in place while others are still under development. The high amount of lingo-cellulosic matter in SG makes it indigestible to many animal species. The majority of SG used for animal feed is fed to ruminants (e.g., dairy cattle and pigs) which can cope with the high fiber content. Dairy cattle fed SG have been showed to increase milk production (Belibasakis and Tsirgogianni, 1996; Reinold, 1997; Sawadogo et al., 1989). SG can be used for this purpose either wet (70-85% moisture content) or dry (10-12% moisture content), the latter being more stable and cheaper to transport, but incurring additional drying costs. Animal feed prices fluctuate according to demand and represent a modest return.

The environmental implications of increased methane emissions from cows fed this hard to digest material can also be considered as having a negative environmental impact. The CO_2 emission of methane is approximately 21, which means that its impact as a greenhouse gas is approximately 21 times greater than that of carbon dioxide. Currently, the primary market for SG is dairy cattle feed, but as the SG provides protein, fiber, and energy, its consumption has also been investigated for a range of animals, including poultry, pigs and fish (Table 3). Kaur and Saxena (2004) evaluated SG as a replacement for rice bran in a fish diet, and observed that fish fed with a diet containing rice bran and 30% spent grain had a superior body weight gain when compared with fish fed with rice bran only. According to these authors, the better growth performance was due to the increased content of proteins and essential amino acids provided by the spent grain.

6.2 SG in Biotechnological Processes:

Bio-ethanol can be produced from starch and sugar-based crops as well as lignocellulosic biomass. Most of the starch and sugar-based crop (sweet sorghum, maize starch, sugarcane, rice, wheat, sorghum, etc.), competes with human food production and also have high production prices makes its industrial production a little difficult. With the increase in demand for ethanol, the search for cheaper and more abundant substrate is underway and also the development of an efficient and less expensive technology so that there will be an increase in availability of ethanol at a cheaper rate (Alam et al., 2007, 2009).

The substantial hemicellulose and cellulose components of SG (approx. 55% of the material on a dry weight basis) consist of polymeric sugars. Cellulose is a polymer of glucose (C-6 sugar) whilst hemicelluloses contain C-5 sugars or pentose's such as xylose and arabinose. If these sugars could be liberated and fermented to generate bio-ethanol, each gallon of ethanol produced will save a gallon of oil. Such processes are still pre-competitive and require step changes in technology to bring them to market. However, second generation bio-fuel technologies are the subject of much current research and novel technologies developed will be applicable to SG, and even to the brewing process itself (Cook, 2011).

The composition of brewer's spent grain (SG) as described in reviewed literatures consist majorly grain husks and other residual compounds such as hemicelluloses, cellulose and lignin (Kanauchi et al., 2001; Russ et al., 2005; Mussatto and Roberto 2006; Mussatto et al., 2008a) and this makes it a good

feedstock for ethanol production. Current technology for the conversion of spent grain (SG) to ethanol requires chemical or enzymatic hydrolysis to produce majorly fermentable sugars, followed by microbial fermentation. Thus, large amounts of enzymes required for enzymatic conversion of cellulose to fermentable sugars impacts severely on the cost effectiveness of this technology.

However, Neurospora crassa and Fusarium oxysporum were found to have an exceptional ability to convert cellulose and hemicellulose directly to ethanol through the consecutive steps of hydrolysis of the polysaccharides and fermentation of the resulting oligosaccharides by secreting all the necessary enzyme systems (Xiros et al., 2008; Xiros and Christakopoulos, 2009). Both Xiros et al. (2008) and Xiros and Christakopoulos (2009) reported the ethanol yield of 74 and 109 g/kg of dry SG by N. crassa and F. oxysporum, respectively under micro aerobic conditions (0.01 vvm). Thus, brewer's spent grain can be used to generate a wide range of feedstock materials to supplement current bio-ethanol production from a starchy feedstock.

7. Economic Sustainability of Bio-Ethanol Produced from Spent Grain:

The economic sustainability of production of bio-ethanol is viewed from two perspectives as highlighted in sections 7.1-7.2

7.1 Profitability and Efficiency:

Before people can invest in bio-ethanol the issue of profitability most be well defined because it is the determining factor for its long term viability and before the issue of profitability comes into play, there should be marketability which determines economic profitability because producers will only be willing to invest in bio-fuel production if it is economically profitable.

The key factors that can affect the profitability of bio-ethanol include the alternative competitive uses of the feed stocks and the energy prices. Alternative uses of the feedstock aids decision making process of producers and if prices for bio-fuels fall below the prices of other possible end-products (food, feed, timber, etc.) it would be more profitable to cultivate these products than to derive fuel out of the feedstock. Accordingly, their prices determine the price floor for bio-fuels. To be profitable and also compete with fossil fuels, bio-ethanol production costs must be lower than the price of its oil equivalent. Therefore, oil prices set a price ceiling for the price of bio-fuels and if the cost exceeds this value, the bio-fuels will automatically be priced out of the market (Schmidhuber, 2007).

7.2 Competition with Food:

One of the major determining factors of the long-term economic feasibility of bio-fuels is its competition with food. According to FAO's definition, food security exists when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 2003, p.29). When feed stocks used for food are also used for bio-ethanol, the food price increases and also the availability of food will be limited by the bio-fuel supply so far they compete for the same resources such as land, fertilizers, water. Therefore, bioethanol's potential competition with food should be considered when investing in bio-fuel; this issue is being tackled by making use of the second generation feed stocks.

The definition considers four dimensions; food availability, food access, food use and food stability. These dimensions are appraised next with regard to bio-energy production expansion. Food availability refers to having sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid). Regarding the impact of bio-fuels expansion of food availability it is important to point that the use of agricultural lands for bio-energy feedstock production is quite low relative to total agricultural land area

The other dimensions of food security are not expected to be significantly affected by the production of bio-fuels. Food access relates to individuals having adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. It depends on purchasing power of the population as well as the availability of adequate transport, storage and distribution infrastructure. Food access can be favored in contexts where bio-energy production stimulates the development of rural production system and increases household disposable income. On the other hand, food access can be negatively affected if bio-fuels development leads to significant food prices increases that reduce purchasing power among the population. Food utilization relates to how food is used through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. Food utilization brings out the importance of non-food inputs in food security; therefore, it is not expected to be meaningfully impacted by bio-fuels development.

Finally, stability refers to the possibility that a population, household or individual has access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can refer to both food availability and food

access. Bio-fuels development can therefore affect the stability dimension of food security through the effects it can have on food availability if fuel uses of agricultural commodities prevail over food uses or production of other food-related agricultural goods is displaced to produce bio-fuel feed stocks. Bio-fuel development can also affect food stability through the effect on food access, negatively if it leads to significant food price increases that reduce purchasing power, or positively if it increases purchasing power among farmers and the general population in bio-fuels producing regions.

8. Bio-Refinery Concept – Looking into its Prospect:

A bio-refinery is a singular facility that produces multiple products from biomass and may be defined as a facility that converts biomass into fuels, chemicals, and power through integrated processes (Ragauskas et al., 2006a). Realff and Abbas (2004) also defined a bio-refinery as a process of converting renewable agricultural feed stocks to higher value added products for use as food, fuel feed, and fiber. Bio-refinery has been defined by International Energy Authority (IEA) as "the sustainable processing of biomass into a spectrum of bio-based products (food, feed, chemicals, and materials) and bio-energy (bio-fuel, power, and/or heat)".

A way to improve the economy and also increase the net energy gain of the production of ethanol from lignocellulose would be to manufacture co-products and important chemicals during the process. In the petroleum industry about 5% of the total output from an ordinary refinery goes into chemical products, while the remaining 95% is used for energy and transportation fuels (Ragauskas et al., 2006b). In the case of breweries and corn ethanol production, an important co-product is spent grain (SG) and distiller's grain, which is used as cattle, fish, and pig feed (Wheals et al., 1999).

A major residual product of cellulosic ethanol from spent grain (SG) is lignin which can be burnt with other solids left after hydrolysis for the generation of heat and electricity (Wyman, 2003). In the cement context, a bio-refinery comprises integrated biomass conversion technologies to produce bio-ethanol and other useful and valuable commodities including energy. There is a wide range of valuable chemicals and materials that can be produced from lignocellulose bio-refinery which includes; cosmetics, nutraceuticals, bio-plastics, solvents, and herbicides. There is also a wide range of valuable products that can be produced from the lignocellulose-derived sugars by microbial conversion. Potential products include hydrogen, methane, propanol, acetone, butanol, butanediol, succinic acid, itaconic acid, acetic acid, levulinic acid, butyraldehyde, ascorbic acid, adipic acid, propylene glycol, acrylic acid, acetaldehyde, sorbitol, glycerol, and malic acid (Kamm and Kamm, 2004; Wyman, 2003).

Another excellent product that can be derived from carbohydrates by microorganisms is lactic acid. Polymeric materials derived from lactic acid, for example polylactide, which is a very versatile thermoplastic, can replace some of the plastics made from petroleum. Polylactide is very popular in the food packaging industry because it is fully compostable and biodegradable and also used in the manufacture of films and fibers (Gruber, 2003). Other plastics, such as polyvinylacetate and polyethylene, can be produced with ethanol as the starting material.

The conversion of the ethanol must be done into ethene by chemical methods (Kamm and Kamm, 2004). An advantage with chemicals produced by microbial catalysis rather than by using petrochemical methods is that the products from the microorganisms are typically stereo and region-chemically pure. There is no need for expensive chiral catalysts and complex syntheses, which is the case in the production of many petrochemicals (Ragauskas et al., 2006b). Even if the major part of the biomass can be utilized in an efficient way in a bio-refinery, there will nevertheless probably be some waste products that are uneconomical to convert further to valuable chemicals or materials.

As mentioned above, residual materials, such as lignin, can be burned to generate power, but another possibility would be thermo chemical conversion of the residues to syngas. The produced syngas can then be used for the production of methanol, ammonia and Fisher-Tropsch hydrocarbons (Ragauskas et al., 2006b). Studies have shown that a cellulosic refinery plant that combines the production of fuels, chemicals and power can generate these products with a lower cost than if just one of them is produced (Wyman, 2003). Another possibility is to transform the pulp mills of today into bio-refineries (Ragauskas et al., 2006a). In essence, the bio-ethanol/ bio-refinery concept is to make the most of the whole bio-mass, rather than just a component of it, using chemicals and bio-technologies in a sustainable manner that reduces waste and saves energy. The concept of "zero emissions" in bio-refinery has been discussed by (Gravitis, 2007).

In addition to ensuring the quality of bio-ethanol processes, quality parameters of the end product are also important. In the US, the American Society for Testing and Material Testing (ASTM) approves analytical specifications for bio-ethanol transportation fuel performance quality (Davis, 2009).

This includes the key parameters to be measured, their units of measurement and their influence on quality. For example, pH and water elimination are important parameters for internal combustion engines. The Renewable Fuel Association (RFA) recommends minimum testing frequencies and method for bio-ethanol to ensure product quality and consistency and to meet ASTM standards.

The production and the use of bio-fuels such as bio-ethanol at the expense of fossil fuels contribute in a meaningful way to reduce GHG emissions. This is because the bio-massfeed stocks employed fixed carbon dioxide photo-synthetically during their growth and this leads to significant reduction in carbon dioxide equivalent GHG emissions compared to oil and gas combustion. Importantly in this context, the combustion of road transport fuel is currently responsible for around 20% of GHG emissions. As it is now clear with scientific evidence that "emissions from economic activity are causing changes to the earth's climate" (Stern, 2007). The US Environmental Protection Agency (EPA) has stated that relative to gasoline, utilization of corn ethanol reduces GHG emission by at least 20% but significantly cellulosic ethanol, especially from spent grain usage reduces emission far in excess of 60% (RFA).

Additional environmental and health benefits of bio-ethanol include: Removal of toxic methyl tertiary-butyl ether (MTBE) as a gasoline oxygenate (especially in the US). Ethanol as an oxygenate reduces harmful exhaust pipe emissions due to complete fuel combustion (ethanol contains 35% oxygen). Toxic and carcinogenic gasoline additives (e.g. lead, benzene is replaced by ethanol), and Ethanol is readily bio-degradable.

First generation bio-ethanol is faced with severe economic and environmental constraints, including contribution to higher food prices (by competing with food crops), production is not cost effective (without government subsidies), limited GHG reduction benefits, dubious sustainability criteria, potential negative impact on bio-diversity, and competition for scarce water resources.

The following represents the most important ethical challenges raised by increasing future bio-ethanol production, economics (affordability), food to fuel (changes in agricultural land use), genetic engineering (empowerment of GM. feed stocks), local environment (localization/ building of new bio-refineries: demands on fresh water), and bio-business (potential monopolization of bio-resources or patents).

9. Conclusion

The full utilization of existing technology and the promise of new developments will make the production of ethanol fuel easier and more economical in the near future. However, as fossil fuel supplies dwindle, it will become increasingly important to utilize every shred of available material and waste in the production of energy. Aside from the large scale production of bio-fuel, self-contained, automatic appliances that could turn all sorts of waste material into useable fuel would be an important development. Electric vehicles and small, regional hydro-electric plants would also help as would full utilization of solar, geothermal, and other energy alternatives. It is of paramount importance to know that the energy problem will not solve itself unless pro-active measures are taken.

Corresponding Author:
J. T. Oladeji, Ph.D.
Department of Mechanical Engineering, Faculty of Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.
E-mail: jtoladeji@lautech.edu.ng

References

1. Adeniran, H. A., Abiose, S. H., & Ogunsua, A. O. (2010). Production of fungal β-amylase and amyl glucosidase on some Nigerian agricultural residues. *Food and bioprocess technology*, 3(5), 693-698.
2. Alam, M. Z., Kabbashi, N. A., & Hussin, S. N. I. (2009). Production of bioethanol by direct bioconversion of oil-palm industrial effluent in a stirred-tank bioreactor. *Journal of industrial microbiology & biotechnology*, 36(6), 801-808..
3. Alam, M. Z., Kabbashi, N. A., & Razak, A. A. (2007*). Statistical Optimization of Process Conditions for Direct Bioconversion of Sewage Treatment Plant Sludge for Bioethanol Production*. In 3rd Kuala Lumpur International Conference on Biomedical Engineering 2006 (pp. 492-495). Springer Berlin Heidelberg.
4. Al-Hadithi, A. N., Muhsen, A. A., & Yaser, A. A. (1985). A study on the possibility of using some organic acids as preservatives for brewer's by products. *Mijalat al-buhwut al-zira*: 3i: a WA al-mawa: rid al-ma:'i: a (Iraq).
5. Aliyu, S., & Bala, M. (2013). Brewer's spent grain: A review of its potentials and applications. *African Journal of Biotechnology*, 10(3), 324-331..
5. Faulds, C., Sancho, A., & Bartolomé, B. (2002). Mono-and dimeric ferulic acid release from brewer's spent grain by fungal feruloyl esterases. *Applied microbiology and biotechnology*, 60(4), 489-494.
6. Belibasakis, N. G., & Tsirgogianni, D. (1996). Effects of wet brewer's grains on milk yield, milk

composition and blood components of dairy cows in hot weather. *Animal feed science and technology*, 57(3), 175-181.
7. Cook, D. (2011*). Brewers' grains*: Opportunities abound. Brewer's Guardian, 60-63.
8. Kelsall, D. R., Austin, G. D., & Kluhspies, C. (2009). The alcohol textbook: a reference for the beverage, *fuel, and industrial alcohol industries*. Nottingham University Press.
9. Duru, M. E., Cakir, A., Kordali, S., Zengin, H., Harmandar, M., Izumi, S., & Hirata, T. (2003). Chemical composition and antifungal properties of essential oils of three Pistacia species. *Fitoterapia*, 74(1), 170-176.
10. El ‐ Shafey, E. I., Gameiro, M. L. F., Correia, P. F. M., & De Carvalho, J. M. R. (2004). Dewatering of brewer's spent grain using a membrane filter press: a pilot plant study. *Separation science and technology*, 39(14), 3237-3261.
11. Erdelji, V., (2007). Bio-ethanol from Brewers and Distillers Spent Grain. University of Abertay *Dundee Yeast Research Group, School of Contemporary Sciences* Feb. 12 – May 07.
12. Bruinsma, J. (2003*). World agriculture: towards* 2015/2030: an FAO perspective. Earthscan.
13. Gravitis, J. (2007). Zero techniques and systems–ZETS strength and weakness. *Journal of Cleaner production,* 15(13), 1190-1197.
14. Kamm, B., & Kamm, M. (2004). Biorefinery-systems. *Chemical and Biochemical Engineering Quarterly*, 18(1), 1-7.
15. Gruber, P.R., (2003) Cargill Dow *LLC Journal of Industrial Ecology* 7: 209-213.
16. Huige, N.J., (1994). *Brewery by-products and effluents, in Hardwick*, W.A. (Ed.), Handbook of Brewing. Marcel Dekker, New York, pp. 501-550.
17. Ikurior, S.A., (1995). *Preservation of Brewers' Year's Slurry by a Simple on Farm Adaptable Technology and its Effect on Performance of weaned Pigs*. Anim. Feed. Sci. Technol. 53: 353-358
18. Kanauchi, O., Mitsuyama, K. and Araki, Y., (2001). Development of a Functional Germinated Barley Foodstuff from Brewers' Spent Grain for the treatment of Ulcerative Colitis. *J. Am. Society of Brewing Chemists*, 59: 59-62.
19. Kaur, V.I., and Saxena, P.K., (2004). Incorporation of Brewery Waste in Supplementary Feed and its Impact on Growth in Some Carps. *Bioresource. Technol*. 91: 101-104.
20. Khidzir, K.M., Noorlidah, A. and Agamuthu, P., (2010). Brewery Spent Grain: Chemical Characteristics and utilization as an Enzyme Substrate. *Malaysian J. Sci*. 29(1):41-51.
21. Kim, S., and Dale, E.B., (2004), Global Potential Bio-ethanol Production from wasted Crops and Crop residues. *Biomass Bio-energy* 26:361–375.
22. Mussatto, S. I. (2009). Biotechnological potential of brewing industry by-products. *In Biotechnology for agro-industrial residues utilization* (pp. 313-326). Springer Netherlands.
23. Mussatto, S.I. and Roberto, I.C., (2006). Chemical Characterization and Liberation of pentose Sugars from Brewers Spent Grain. *J. Chem. Technol. Bio-technol*. 81: 268-274.
24. Mussatto, S.I., Rocha, G.J.M. and Roberto, I.C., (2008*). Hydrogen Peroxide bleaching of cellulose Pulps obtained from Brewer's Spent Grain. Cellulose* 15:641-649.
25. Olugbenga, O and Ibileke, I.O., (2011). Bio-ethanol Production from Brewer's Spent Grain, bread Wastes, and corn Fibre. *African journal of food science*. 5(3):148-155.
26. Pokhrel, C.P., Yadav, R.K.P. and Ohga, S., (2008). *Agricultural Waste Residues as Potential Sources of Bio-ethanol. Scientific World*, 6:19-23.
27. Ragauskas, A. J., Nagy, M., Kim, D. H., Eckert, C. A., Hallett, J. P., & Liotta, C. L. (2006). From wood to fuels: integrating biofuels and pulp production. *Industrial biotechnology*, 2(1), 55-65.
28. Ragauskas, A.J., Williams, C.K., Davison, B.H., Britovsek, G., Cairney, J., Eckert, C.A., Frederick Jr., W.J., Hallett, J.P., Leak, D.J., Liotta, C.L., Mielenz, J.R., Murphy, R., Templer, R., Tschaplinski, T. (2006b). *The Path Forward for Bio-fuels and Bio-materials*.
29. Realff, M.J. and Abbas, C.A., (2004). Industrial Symbiosis: Refining the Bio-refinery*: Journal of Industrial Ecology*, 7 :(3-4):5-9
30. Reinold, M.R., (1997). Manual Pratico de Cervejaria*, First Ed. Aden Editora e Comunicac¸o˜es Ltda, Sa˜o Paulo*. p.214
31. Robertson, J.A.I., Anson, K.J.A., Treimo, J., Faulds, C.B., Brocklehurst, T.F., Eijsink, V.G.H., and Waldron, K.W., (2010*). Profiling Brewers 'Spent Grain for Composition and Microbial Ecology at the site of Production. LWT Food Sci. Technol*. 43: 890-896.
32. Russ, W., Mo¨rtel, H., and Meyer-Pittroff, R., (2005). Application of Spent Grains to increase Porosity in Bricks. *Construction and Building Materials* 19, 117–126.
33. Salihu, A. and Muntari, B., (2011) "Brewer's Spent Grain: A review of its Potentials and Applications" *African Journal of Biotechnology*, 10(3): 324-331.
34. Santos, M., Jimenez, J.J., Bartolome, B., Gomez-Cordoves, C. and Del Nozal, M.J., (2003).

Variability of Brewer's Spent Grain within a Brewery. Food Chem. 80: 17-21.
35. Sawadogo, L., Sepehri, H., Houdebine, L.M., (1989). The presence of a Factor Stimulating Prolactin and Growth Hormone Secretion in Brewers' Spent Grains. *Reproduction, Nutrition*, Development 29: 139–146.
36. Schmidhuber, J., & Tubiello, F. N. (2007). Global food security under climate change. *Proceedings of the National Academy of Sciences*, 104(50), 19703-19708.
37. Stern, N., (2007*). The Economy of Climate Change. The Stern Review*. Cambridge University Press.
38. Tang, Z., Cenkowski, S., & Izydorczyk, M. (2005). Thin-layer drying of spent grains in superheated steam. *Journal of Food Engineering,* 67(4), 457-465.
39. Tang, D. S., Yin, G. M., He, Y. Z., Hu, S. Q., Li, B., Li, L., ... & Borthakur, D. (2009). Recovery of protein from brewer's spent grain by ultrafiltration. *Biochemical Engineering Journal,* 48(1), 1-5.
40. Wheals, A. E., Basso, L. C., Alves, D. M., & Amorim, H. V. (1999). Fuel ethanol after 25 years. *Trends in biotechnology*, 17(12), 482-487.
41. White, J. S., Yohannan, B. K., & Walker, G. M. (2008). Bioconversion of brewer's spent grains to bioethanol. *FEMS yeast research*, 8(7), 1175-1184.
42. Wyman, C. E. (2003). Potential synergies and challenges in refining cellulosic biomass to fuels, chemicals, and power. *Biotechnology progress,* 19(2), 254-262.
43. Xiros, C., & Christakopoulos, P. (2009). Enhanced ethanol production from brewer's spent grain by a Fusarium oxysporum consolidated system. *Biotechnology for Biofuels*, 2(1), 1.
44. Xiros, C., Topakas, E., Katapodis, P., & Christakopoulos, P. (2008). Hydrolysis and fermentation of brewer's spent grain by Neurospora crassa. *Bioresource technology*, 99(13), 5427-5435.
45. Yablochkova, E. N., Bolotnikova, O. I., Mikhailova, N. P., Nemova, N. N., & Ginak, A. I. (2003). Specific features of fermentation of D-xylose and D-glucose by xylose-assimilating yeasts. *Applied Biochemistry and Microbiology*, 39(3), 265-269.
46. Yohannan, B. K., White, J. S., Bennett, J., & Walker, G. M. (2010). Distiller's spent grains: A substrate for bioethanol*? Distilled Spirits, Volume 3: New Horizons: Energy, Environment, and Enlightenment*, 3, 147.

Received January 26, 2016; revised February 16, 2016; accepted February 28, 2016; published online April 1, 2016.

Petroleum Coke Carbon, Characterization, and Environmental Application

M. S. Suliman* • S. I. Bakhit Yasin • M.S. Ali Eltoum

Chemistry Department, College of Science, Sudan University of Science and Technology, Sudan
abotrteel74@gmail.com

Abstract: Activated carbons were prepared from petroleum coke of Khartoum Refinery Company delayed coke unit (KRC-DCU) by chemical activation methods with KOH as active agent, It has been found that under the identical experimental conditions the porous carbon obtained was about 68–61% in yield, Iodine Number and Methylene Blue around 1248.1-1242 mg/g and 43- 51mg/g respectively, The results showed that the carbon obtained from coke by KOH activation in ratio 1:4-1:5 Coke: KOH and 60 min activation time is less in time and cost in comparison to the traditional methods. It also observed that the adsorption of Zn2+ on petroleum active carbon depends on the pH of solutions, contact time, and doses of adsorbent. Adsorption of Zinc+2 from water was found to fit Freundlich isotherm model with a linear curve and R ≈ 0.9731.

To cite this article
[Suliman, M. S., Bakhit Yasin, S. I., & Ali Eltoum, M. S. (2016). Petroleum Coke Carbon, Characterization, and Environmental Application. *The Journal of Middle East and North Africa Sciences*, 2(4), 10-14]. (P-ISSN 2412-9763) - (e-ISSN 2412-8937). http://www.jomenas.org. **2**

Keywords: Petroleum coke; activated carbon; iodine number; methylene blue; adsorption.

1. Introduction:

Activated Carbon (AC) and Carbon Molecular Sieves (CMS), are characterized by a high specific surface area and high pore volume in the carbon matrix. They can adsorb molecules in liquid and gaseous phase. CMS is used in several areas of science and technology and in many industries. AC belongs to the family of advanced carbon materials, due its microspore characteristics, such as high surface area, high adsorption capacity and high reactivity (González, Molina-Sabio, & Rodriguez-Reinoso, 1994; Bansal, Donnet, & Stoeckli, 1988).

The conventional process to produce CMS and AC use as raw materials: carbon from fossil origin, such as coal and anthracite; biomass precursors, such as wood and cellulose fibers; synthetic materials, such as carbon fibers and carbon fibers felts, and others. The process consists in the carbonization of raw materials at temperatures between 600 ºC and 650 ºC, followed by a partial gasification or activation with air, steam or carbon dioxide, between temperatures of 800 ºC and 900 ºC, to develop an appropriate porous structure (Walker, 1968; Coutinho, Rocha, & Luengo, 2000; Metcalfe, Kawahata, & Walker, 1963) were the first to describe a production of CMS, when they activated anthracite, using CO2 as activating agent.

The produced sieve was employed to separate n-butane, isobutane, and n-pentane. Petroleum coke is a residue with high carbon content and low ash content. Due to its practically amorphous structure, it is a material of little commercial value, being considered a troublesome residue, both to economically and to the environment. Therefore, the use of petroleum coke for the production of AC and CMS, through physical activation and/or chemical activation, is a promising way to use this residue.

Zinc is one of the most important heavy –metal pollutants in waste water and treated water (WHO, 1971). It is leached in water, mainly, from corrosion of galvanized metals (Faust & Aly, 1998) and when used as a micronutrient in agriculture. Its removal from water using different types of activated carbons and has, therefore, been the subject matter of several investigations (Marzel, Seco, Gabaldon, Ferror, 1996).

The objective of the present work is to evaluate how process parameters affect the porosity of the AC from the delayed coking unit of Khartoum Refinery Company (KRC) obtained by chemical activation (Rand, Hosty, West, & Marsh, 1989). In addition to the first objective the second one, is to study the adsorption of zinc ion from an aqueous solution in to activated carbon experimentally with different parameters.

2. Material and Methods:

The chemical activation experiments were carried out impregnating 1 g of petroleum coke with an aqueous solution of potassium hydroxide (KOH).

The resultant mixture was then evaporated at 150 C° and heated up by an electric furnace with heating rate control 25C°/ min and temperature control with different activation times starting from 30, 45 and 60 min (Chunlan, Shaoping, Yixiong, Shuqin, Changhou, 2005). Afterward, all the activated carbon produced were washed with hydrochloric acid (10%) then with hot and cold distilled water to remove the alkali metal and ashes until the filtrate neutralized.

2.1. Active carbon Sample:

Active carbon sample characterize by (FT- IR) to present main function group of active carbon, Characterization was performed using an Infrared spectrophotometer FT, IR 84005 Shimadzu, in wavelength 4000 to 400 fig (1).

Information about the structure of activated carbons can be obtained by the adsorption characteristics of different adsorbates, such as methylene blue and iodine. Adsorption experiments of these molecules are easy and habitually done to characterize activated carbons for the purpose of obtaining information on the adsorption capacity of the materials.

Iodine Number (IN):

The iodine value, defined as the amount of iodine adsorbed per gram of activated carbon at an equilibrium (European Council of chemical manufacturers, 1986). The iodine number is determined according to the ASTM D4607-94 method.

Methylene blue number (MBN):

The methylene blue number is defined as the maximum amount of dye adsorbed on 1.0 g of adsorbent was measured according to the procedure established by the (European council of Chemical Manufacturers Federations., 1986) The remaining concentration of methylene blue is analyzed using a UV/Vis spectrophotometer SHIMADZU 1800.

2.2 Adsorption capacity of Zinc (+2) Method:

500 cm-3 of 120 (ppm) Zinc (+2) volumetric flasks. A 100 cm-3 of each was mixed in 250 cm-3 beakers with 0.01, 0.03, 0,06,0.09 and 0.12 g, the mixtures were stirred for 15 min and allowed to settle for 48 hrs. before they were filtered. The residual metal ion concentration of the filtrate was determined using Atomic adsorption spectrometer ICE 3000 series Thermo Scientific-USA and presented table 1 and figures 1 and 2.

2.3 Effect of equilibrium time and pH method:

A carbon dose of 0.1 g was added to 50 cm3 solution the pH of each sample was adjusted to 2,4,6,8 and 10 consequently using 5 M Hydrochloric acid and 5 M Ammonium solution, calibrated pH-meter was used to measure the pH of the samples by (pH meter model 3305 Jenway UK). The final concentration of each sample was measured using Atomic absorption.

2.4 Evaluation of Data:

The removal percentage of active carbon was calculated according to equation:-

$$\text{Metal removal\%} = (Co-C)/Co*100 \quad (1)$$

Where Co and C are initial and final concentration (mg/l) of the metal ions solution contact with the mass of carbon.

The amount of Zn2+ adsorbed by active carbon was determined by using mass balance equation

$$qe = (v\ (Co-C))/m \quad (2)$$

Where qe is the metal concentration on the zeolite carbon (mg/l) at equilibrium, C is metal concentration in solution (mg/l) at equilibrium, Co is initial metal concentration in solution (mg/l), v is volume of initial metal solution used (ml) and m is mass of zeolite used (g) (Shahmohammadi-Kalalagh, 2011).

3. Results and Discussion:

3.1. Activated carbon yields:

Results show that the ACs yield mainly depends on the amount of activation agent added, results in the table (1) showed that, the increasing of the activation agent amount increased the yield, due to the sufficiency of the activation agent loaded on the coke during impregnation which prevents volatilization of carbon during activation.

Table (1): *Results of yield different activation times.*

KOH: Coke	Yield % (30 min)	Yield % (45 min)	Yield % (60 min)
1:1	58.20	21.20	28.40
2:1	45.10	25.30	22.00
3:1	45.00	52.10	50.00
4:1	N/A	N/A	68.70
5:1	N/A	N/A	61.00

3.2 FT-IR spectroscopic:

FT-IR study of the produced carbon is shown in Figure 1. The sample showed four major absorption bands at 2900-3500 cm-1, 1300-1750 cm-1, 1000-1250 cm-1 and 450-900 cm-1. A wide band with two maximum peaks can be noticed at 2930 and 3450 cm-

1. The band at 3452 cm- 1 is due to the absorption of water molecules as a result of an O-H stretching mode of hydroxyl groups and adsorbed water while the band at 3037 cm- 1 is attributed to C-H interaction with the surface of the carbon. However, it must be indicated that the bands in the range of 3200-3650 cm- 1 have also been attributed to the hydrogen-bonded OH group of alcohols and phenols (Yang & Lua, 2003; Puziy et al., 2003). In the region 1300-1750 cm- 1, amides can be distinguished on the surface of the activated carbon which has two peaks at 1640 and 1450 cm- 1. These functional groups were obtained during the activation process as a result of the presence of ammonia and primary amines that usually exist. Moreover, the band at 1525 cm- 1 may be attributed to the aromatic carbon–carbon stretching vibration. The two peaks at 1143-1193 cm- 1 yield the fingerprint of this carbon. The sharp absorption band at 1087 cm- 1 is ascribed to either Si-O (Misra, Tyagi, Singh, & Misra, 2006).

The band at 1143 cm-1 can also be associated with ether C-O symmetric and asymmetric stretching vibration (-C-O-C- ring) (Wu et al., 2004).

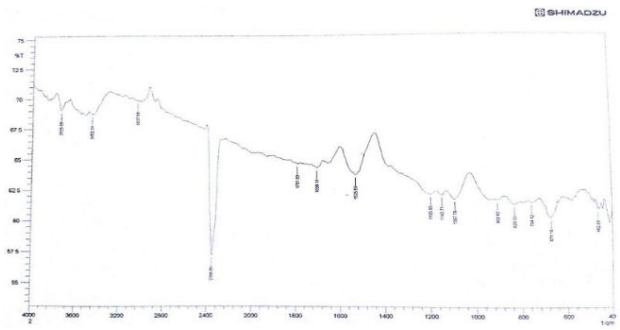


Fig (1). IR Spectrum of Activated carbon.

3.3 Effect of activation time on iodine number and methylene blue adsorption:

The process parameters, such as activation time, also have much effect on the pore structure of the final products results are presented in table no 2 and3 and. As can be observed by changing the activation time the behavior of iodine number and methylene blue becomes more influenced, it was evidenced that the yield of activated carbon increased with increasing of activation time. The iodine number and methylene blue increased gradually too when the Activation time increased gradually, and the reason is that more diffusion can occur during activation and more reaction time (Wu et al., 2004).

Table (2): *Results of Iodine Number at different activation time.*

KOH: Coke	IN mgg-1 (30 min)	I N mgg-1 (45 min)	IN mgg-1 (60 min)
1:1	211.50	93.20	64.88
2:1	267.00	326.00	460.70
3:1	760.50	823.30	1119.50
4:1	N/A	N/A	1248.10
5:1	N/A	N/A	1242.40
0:1	N/A	N/A	260.00

Table (3): *Results of Methylene blue number at different activation times.*

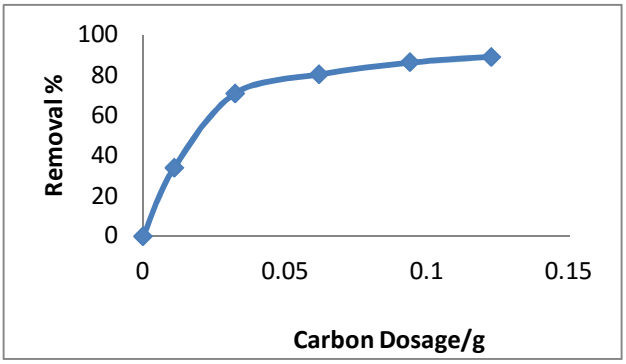
KOH: Coke	MB mgg-1 (30 min)	MB mgg-1 (45 min)	MB mgg-1 (60 min)
1:1	4.00	5.00	4.40
2:1	7.70	23.60	16.40
3:1	11.80	32.60	43.00
4:1	N/A	N/A	46.00
5:1	N/A	N/A	51.60
0:1	N/A	N/A	1.50

3.4 Zinc (+2) adsorption on activated carbon:

Many parameters affect on adsorption like carbon doses, pH, contact time and temperature of the medium.

3.4.1 Effect of carbon doses:

Zinc (+2) removal increases with the increasing of carbon doses. Data presented in Figure 2 can be used to determine the required carbon dosage to the desirable treatment concentration. However, the remaining solution concentration changed on treatment with different weights of the package -based



activated carbon, the high adsorption capacity as much as 382 mg/g was obtained.

Fig (2). Effect of Carbon dosage on adsorption removal of Zinc2+.

3.4.2 The effect of pH:

Very important parameter in adsorption, the study of effect of pH using different solution pH value from 2 to 10 at room temperature and 120ppm,

activated carbons had higher adsorptive capacities at pH 4, at pH 2 also the adsorptive capacity of activated carbon is high .whoever, increasing in the pH of the solution to 6, 8 and 10, Adsorption equilibrium time was also investigated after different contact time starting with 24 hrs.' for each pH and it found that with the increasing in the contact time the amount of impurities adsorbed were also increased and reached the equilibrium after 72 hours.

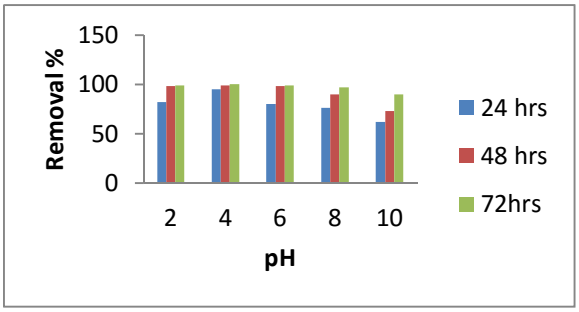


Fig (3) Effect of pH on adsorption of Zn2+ after different equilibrium times

3.5 Adsorption isotherms:

Freundlich model supposes that uptake or adsorption of metal ions occurs on the heterogeneous surface by monolayer adsorption. The equation of this model is described following like this

$$qe = K_f(Ce)^{1/n} \quad (3)$$

The Freundlich equation can be linearized by taking logarithms and constants can be determined. The above equation can be linearized as follows:

$$\text{Log } (qe) = \log (k_f + 1/n \log (Ce) \quad (4)$$

Where kf and 1/n are Freundlich constants related to adsorption capacity and adsorption intensity, respectively. The initial concentrations of Zn2+ were varied and the adsorbent dose was kept constant in order to determine the equilibrium isotherms.

The constants k and 1/n were 1.25 and 0.509 respectively were found, the position and slope of the isotherm line revealed the performance of the activated carbon. The representation of the experimental data by Freundlich equation resulted in a linear curve with r ≈ 0.9731. Generally, higher isotherm line means that the carbon has better adsorptive capacity than the lower line and carbon that has a higher x/m value at a specified equilibrium concentration, which was 368 mg/g (5.6 mmol/g).

Table (4): *Zinc (+2) adsorption on activated carbon.*

Carbon Wt.	C_e	Log C_e	x/m	Log x/m	Removal %
0.0109	39.7	1.598	368.3486	2.566259	66.91
0.0323	35.86	1.554	260.4954	2.4158	70.11
0.062	23.96	1.379	154.9032	2.19006	80.03
0.094	16.73	1.223	109.8617	2.040846	86.05
0.1225	13.35	1.125	87.06122	1.939825	88.87

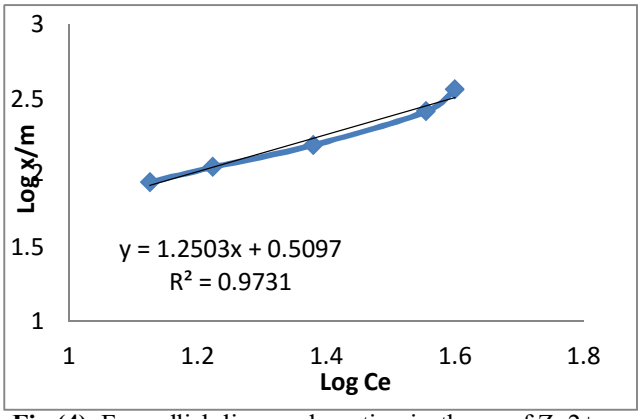


Fig (4). Freundlich linear adsorption isotherm of Zn2+.

4. Conclusion:

The results of this study show that it is feasible to prepare activated carbons with relatively high iodine value (1248.10 mg/gm) and methylene blue value (51.0 mg/gm) from petroleum coke by direct chemical activation using potassium hydroxide as the activation agent. And capable of using in adsorption of heavy metals from waste water and the obtained activated carbon has higher adsorption capacity towards Zinc (II), the obtained isotherm was found to fit Freundlich isotherm model.

Corresponding Author:
Mohamed S.Ali, Ph.D.
Chemistry Department, College of Science, Sudan University of Science and Technology, Sudan
E-mail: abotrteel74@gmail.com

References

1-Bansal, R. C., Donnet, J. B., Stoeckli, F. (1988). *Active Carbon*. Marcel Dekker Inc.: New York.

2- Chunlan, L., Shaoping, X., Yixiong, G., Shuqin, L., & Changhou, L. (2005). Effect of pre-carbonization of petroleum cokes on chemical activation process with KOH. Carbon, 43(11), 2295-2301.

3- Coutinho, A. R., Rocha, J. D., Luengo, C. A. (2000). Preparing and characterizing bio carbon electrodes. *Fuel Processing Technology*, Vol. 67, No. 2, pp.93-102, UK.

4- European Council of chemical manufacturers (1986), *federations*, test methods of activated carbon.

5- Faust, S. D., & Aly, O. M. (1998). *Chemistry of water treatment.* CRC Press.

6- González, M. T., Molina-Sabio, M., & Rodriguez-Reinoso, F. (1994). Steam activation of olive stone chars, development of porosity. *Carbon*, 32(8), 1407-1413.

7- Marzel, P., Seco, A., Gabaldon, C., and Ferror, J., J. (1996). Chem. Technol. *Biotechnology*., 66-297.

8- Metcalfe, J. E., Kawahata, M., & Walker, P. L. (1963). Molecular sieve properties of activated anthracite. *Fuel*, 42(3), 233-238.

9- Misra, A., Tyagi, P. K., Singh, M. K., & Misra, D. S. (2006). FTIR studies of nitrogen-doped carbon nanotubes. *Diamond and related materials*, 15(2), 385-388.

10- Puziy, A. M., Poddubnaya, O. I., Martınez-Alonso, A., Suárez-Garcıa, F., & Tascón, J. M. D. (2003). Synthetic carbons activated with phosphoric acid III. Carbons prepared in air. *Carbon*, 41(6), 1181-1191.

11- Rand, B., Hosty, A. J., West, S., & Marsh, H. (1989). *Introduction to carbon science. Butterworths, London*, 75-92.

12- Shahmohammadi-Kalalagh, S. (2011). Isotherm and kinetic studies on adsorption of Pb, Zn and Cu by kaolinite. *Caspian Journal of Environmental Sciences*, 9(2), 243-255.

13-Walker, W. (1968*). Chemistry and Physics of Carbon,* Marcel Dekker: New York.

14- World Health Organization. (1971). Beryllium in drinking-water: background document for development of WHO guidelines for drinking-water quality.

15- Wu, M., Zha, Q., Qiu, J., Guo, Y., Shang, H., & Yuan, A. (2004). Preparation and characterization of porous carbons from PAN-based preoxidized cloth by KOH activation. Carbon, 42(1), 205-210.

16-Yang, T., & Lua, A. C. (2003). Characteristics of activated carbons prepared from pistachio-nut shells by physical activation. *Journal of Colloid and Interface Science,* 267(2), 408-417.

Received February 01, 2016; revised February 17, 2016; accepted march 01, 2016; published online April 01, 2016.

The Role of Consumer Involvement in Organizations for Crafting Strong Relationships with Consumers

Muhammad Shahid[1*] • Muhammad Nadeem[2] • Usman Mehmood[3]

[1]MS Scholar, Institute of Southern Punjab, Pakistan
[2]Faculty of Management, National University of Modern Languages, Pakistan
[3]Faculty of Management, Institute of Southern Punjab, Pakistan
muhammadnadeem19@gmail.com

Abstract: The idea that consumers differ in the amount and type of effort they put into shopping is not new to marketing. Consumer Involvement is a need-based motivational attitude toward information systems and their development. The Means-Ends Chain (MEC) approach is used to identify the consequences and values that consumers attach to product attributes. Attributes differentiate competing products from each other in the mind of the consumers. Consumers' involvement with purchasing influences their purchase behavior and that different consumer types (market segments) can be identified on the basis of their involvement. Purchasing involvement is a promising variable in marketing for three reasons. First, it may be combined with products and situation involvement to better explain buying behavior. Second, it is possible that purchasing involvement may be significantly related to personality variables. Third, and perhaps of most immediate practical significance, purchasing involvement may be related to a number of purchasing activities which are not product specific and significantly impact marketing strategy.

To cite this article
[Shahid, M., Nadeem, M., & Mehmood, U. (2016). The Role of Consumer Involvement in Organizations for Crafting Strong Relationships with Consumers. *The Journal of Middle East and North Africa Sciences*, 2(4), 15-30]. (P-ISSN 2412- 9763) - (e-ISSN 2412-8937). http://www.jomenas.org. **3**

Keywords: Consumer, consumer involvement, relationship marketing, purchase intentions, culture, society, Consumers' learning, willingness to use, brand loyalty, customer satisfaction.

1. Introduction

Consumer Involvement is a need-based motivational attitude toward information systems and their development. As such, it has important implications for the successful creation and deployment of information systems in organizations. For firms to be able to differentiate their market offerings from those of competitors, knowledge about eh consumer is essential. The Means-Ends Chain (MEC) approach is used to identify the consequences and values that consumers attach to product attributes. Attributes differentiate competing products from each other in the mind of the consumers. It is important to all firms in a value chain to identify which attributes are perceived self-relevant by their segment.

Some studies have been conducted on consumers' attitudes towards products. In order to satisfy the consumers and create their involvement towards the product, we as an organization have to develop the loyalty of the product in the minds of the consumers. To create and develop a loyalty in the consumers' minds is not too lasting as compared to the retaining of that loyalty in the consumers because the value of a product is largely determined by the number of loyal customers. Once the customers are satisfied, only then they will be able to purchase the products.

Innovation diffusion theory (Rogers 1983) provides a general explanation for the manner in which new things and ideas disseminate through social systems over time. In the diffusion of innovation literature, an innovation is "an idea or behavior that is new to the organization adopting it" (Swanson, 1994). The theory has a communication-oriented view of innovation-based change with a focus at the individual level of the process. Information system (IS) studies utilizing the theory have therefore considered individual characteristics and perceptions, as well as other theory elements such as social norms, communication channels, opinion leaders, technology champions, the time factor, and the characteristics of the technology being implemented (Brancheau and Wetherbe, 1990; Moore and Benbasat, 1991; Hoffer and Alexander, 1992; Borton and Brancheau, 1993; Swanson). Roger's theory appears to be quite applicable to implantation

of information technologies in organizations, albeit imperfectly (Brancheau and Wetherbel; Attewell, 1992). An important consideration in studies that utilize innovation diffusion theory is how potential adopters' perceptions of the innovation influence the diffusion process (Moore and Benbasat, 1991).

The idea that consumers differ in the amount and type of effort they put into shopping is not new to marketing (Katona and Mueller 1955, Newman and Staelin 1972). Such differences are important to marketers because they influence consumers' reactions to marketing strategies. For example, Westbrook and Fornell (1979) found four distinctive styles of information search among durable goods buyers, ranging from the objective shopper, at one extreme, who makes extensive use of printed sources and in-store shopping guides, to the personal advice seeker, at the other extreme, who relies primarily on personal sources for making buying decisions. Wesbrook and Fornell recommend a low-key approach featuring promotional techniques that provide a great deal of factual information for the objective shoppers. For the personal advice seeker, however, they recommend a more aggressive, personal, sales-oriented, approach. Certainly different strategies would apply to the objective shoppers and the personal advice seekers. Thus, the amount and type of search effort expended by a market segment are an important determinant of the appropriate marketing strategy for that segment.

Kassarjian (1981) has recently related search effort to the notion of consumer involvement. He states that it is undeniable that there are differences between individuals which, regardless of the product or situation, make some people more interested, concerned, or involved in the consumer decision process. Kassarjian proposes that consumers' involvement with purchasing influences their purchase behavior and that different consumer types (market segments) can be identified on the basis of their involvement. Kassarjian combines the product and situation effects so that he can concentrate on differences between consumers with respect to their involvement in purchasing. He suggests that most of our consumer behavior research has been done with upper middle-class (often student) subjects who would tend to be more highly involved in purchasing than other groups. Furthermore, most of our consumer behavior models relate to highly involved consumers purchasing high involvement products. Kassarjian describes two low involvement consumers, the detached consumer who may be more involved in work or other activities than in purchasing, and the "low-low" involvement consumer who is apathetic about most things.

Purchasing involvement is a promising variable in marketing for three reasons. First, it may be combined with products and situation involvement to better explain buying behavior. This would mean that consumer segments could be identified in terms of their levels of purchasing involvement and that marketing strategy could be adjusted according to the combined effects of product, situation, and purchasing involvement on buyer behavior. Second, it is possible that purchasing involvement may be significantly related to personality variables as Kassarjian hypothesizes. This would provide one of the few meaningful links between personality and consumer behavior. Third, and perhaps of most immediate practical significance, purchasing involvement may be related to a number of purchasing activities which are not product specific and significantly impact marketing strategy. For example, the development of meaningful market segments regarding purchasing involvement could be of great assistance to companies that use direct mail advertising, send out catalogs, use coupons or stamps as sales incentives, or sponsor retail sales events. Thus, the concept of purchasing involvement should be useful for both understanding consumer behavior and developing a marketing strategy.

Traditional human factors heuristic evaluations as aimed by (Nielsen 1993) usually consider a hermetic system for analysis, i.e. avoid the influence of external variables from the human compute system, as environmental characteristics, user's motivation, and other media influences. However, while considering consumer behavior models in usability evaluation of commercial websites, the motivation of the user as a costumer becomes a parameter of performance. For instance, it could give hypotheses about why sites that were completely "approved "using traditional checklists have low performance or consumer avoidance. The models of consumer behavior aim at understanding consumer motivations, or why some type of products and brands can induce great cognitive effort of the costumers and others are completely ignored. This field regards the influence of media content and type of products advertised to an effective call to action, i.e., the power of communication to induce decision-making on the idea or the purchase that is being communicated.

The studies suggested that consumer decision-making was a long-term process composed of six steps: awareness, knowledge, linking, preference, conviction, and purchase. The model was called hierarchy of effects (Ray 1973) and was later simplified to the cognition-affect-conation or learning route model. It was observed that this sequence does not necessarily follow a hierarchical route, but can be influenced by consumer involvement with the

product. Involvement is linked to a wide range of causes that include personal characteristics, such as age and sex; social characteristics, such as groups of influence and cultural values; product characteristics, and media format. In this sense, some products are naturally more susceptible to instigate involvement in buying decision, as expensive products or goods linked with a social identification of status. For this reason, high involvement products instigate a natural need for seeking for information (Vaughn 1980). Consequently, buying decision is an exhaustive cognitive effort that involves the balance of psychological and social variables.

There has also been an effort underway to extend Fishbein and Ajzen's theory so that it might better accommodate consumers' motivations or the intentions expressed by their "goals", "trying" or "desires" to consume (Bagozzi & Edwards, 1998; Bagozzi & Warshaw, 1990). These variables have been used as mediators between attitude and behavior. One recent and fundamental approach or construct that tries to explain the structure of attitude and attitude-behavior relationships is the theory of attitude strengths (Petty & krosnick, 1995). Intentions, goals, desire or other motivational constructs used as mediator s between attitude and behavior have some counterparts in attitude strength theory. Involvement is controversial due to the many different proposals and ideas for conceptualizing and measuring the involvement construct (Thomsen et al., 1995).

Within an attitudinal strength perspective, attitude importance or involvement is defined as an individual's subjective sense of the concern, care, and significance he or she attaches to an attitude (Boninger et al., 1995). Bloch and Richins (1983) define enduring importance and involvement as a long-term, cross-situational perception of product or product class importance based on the strength of the product's relationship to central needs and values. Enduring involvement reflects a sustained level of care or concern with an issue, product or activity. The argument that involvement is related to goals and consumer behavior is also confirmed by a few studies testing the positive relationship between involvement and frequent buying behavior (Gainer, 1993; Mittal & Lee, 1989). Involvement is a motivational construct related to attitude and behavioral outcome as a mediator construct in the same way as other proposed mediators such as behavioral intention, desire, goals, planning, or intention to try (Bagozzi &Edwards, 1998).

As a social psychological construct, involvement is described by Koziey and Anderson (1989) as a part of a person's individual cognitive map that affects his or her model of reality and gives form to his or her behavior in everyday situations. In the consumer behavior literature, this concept has been closely allied to the information-processing perspective on behavior and has been considered to be an individual difference variable, identified as a causal or motivating factor with direct consequences for consumers, purchase and communication behaviors (Sherif & Cantril, 1947; Krugman, 1965, 1967; Rothschild, 1979; Mitchell, 1981; Greenwald and Levitt, 1984; Batra, 1985; Kassarjian, 1981).

In common with most marketing theory, however, the involvement construct has been developed, almost without exception, using physical products both in conceptualization and in empirical testing. Over the past decade, however, there has been an increasing recognition that services, as a distinctive product class, have characteristics that require special attention from marketing theorists. Day, Stafford, and Camacho (1995), in their review of current involvement research, highlight the need to investigate more fully the nature of service involvement and the way in which the characteristics of service-based products have different impacts on consumer responses. Because involvement has been shown to be a significant antecedent of purchase behavior in relation to physical products, it has been assumed that it should be equally applicable to the purchase of services. Zaichowsky (1985), for example, presented her Personal Involvement Inventory as one that was context free and applicable to all "Product" types. This view is based upon a belief that consumer behavior in services does not differ enough from that associated with physical goods for it to require separate consideration. However, there is considerable recent research to suggest that this is a naïve assumption. Murray and Schlacter (1990), Zeithmal (1981), and Gabbott& Hogg (1994), among others, point to differences in choice, evaluation criteria, and consumer response.

A number of variables have been shown to be integral to the service consumption decision. Although it is not possible to take account of all of these, four were identified as being particularly relevant in this context: perceived extensiveness of the choice set; the durability of the product benefit; familiarity with the service; and perceived expense (Wilson, 1972; Zeithaml, 1981; Gabbott & Hogg, 1994; Lovelock, 1996). The first of these, the perceived differences between alternatives, was suggested by Laurent and Kapfere in their original work in 1985. Assael (1981) had already shown that when consumers are involved in purchase decisions, the absolute number of alternatives available is not as important as the perceived differences between these alternatives. For example, one reason consumers don't change doctors unless they are extremely dissatisfied is not a lack of alternatives, but the fact

that they don't perceive a sufficient difference between alternate doctors. It is also extremely difficult to assess differences between service products before consumption. Equally, in the case of services, the perceived extensiveness of the choice set may also include the possibility of carrying out the service themselves. Zeithaml (1981) suggests that for a number of services, consumers have the option of employing a service provider to carry out tasks that consumers are capable of doing themselves. These services can be distinguished from services that are either too difficult or too technically complex for the consumer to carry out, or require specialized knowledge.

The second noninvolvement variable identified in this context is the duration of the benefits or the amount of time the consumer expects the benefits of the service to last (Wilson, 1972). In discussing hairdressing services, the benefit of a haircut lasts until the hair needs cutting again, possibly 6 weeks or more; whereas, the benefit of a meal lasts only until the consumer is hungry again, which is likely to be 6 hours. As Lovelock (1996) points out, some services theoretically last a lifetime; for example, higher education; whereas, others only last for as long as the delivery takes; for example, entertainment. Consumers' perception of the durability of the benefit is long term; consumers are likely to behave differently than they would for a relatively short-term benefit, where such a purchase can be made again in the future.

The final noninvolvement variable identified is price or the perceived expense of the service. Price has been shown to influence consumer behavior in a number of studies and can result in an extended information search activity (Domermuth & Cundiff, 1967; Keil & Layton, 1981). However, the price is a difficult concept to operational, because it is not absolute, but subjective and dependent upon an understanding of how the consumer perceives value. Dickson & Sawyer (1990) suggest that the importance of price is often over-rated, because consumers frequently are unaware of the price of individual items, and price only has meaning relative to income. The nature of services and the pricing policies of many service providers suggest that, in this context, the price is a source of considerable uncertainty (Murray & Schlacter, 1990).

There remains diversity of opinion on the nature of involvement and recognition of the failure to define it (Mitchell, 1979). Perceived personal relevance (Higie & Feik, 1989; Peter & Olsen, 1987; Zaickowsky, 1985) and a motivational state activated by a stimulus, situation or decision task (Mittal, 1989) appears to be central to many definitions and reflect the treatment of involvement as an individual trait. The consumer has to be involved with something, hence the focus on product involvement and the interest in explaining differences between products or decision processes in terms of the involvement construct. Mittal (1982) argues that the level of involvement is related to needs and motives and always has direction in terms of the product within a choice context. According to Laaksonen (1994), Mittal recognizes the importance of the environmental and situational factors as well as the person-objective interaction. Most of this relate to the choice of brands and the purchasing/marketing context. There is an argument that the task environment should be viewed more comprehensively, and the conceptualization of the involvement using a response-based approach, as opposed to a cognitively based approach proposed by Laaksonen, treats involvement "as a mental or behavioral reaction of an individual facing a task to be accomplished" (1994: 61). In this respect, the task might be envisaged as comprising more than those activities associated with the purchase context. Laaksonen suggests "it (involvement) is a mediating variable, acting between stimulus object and response and depending on both the characteristics of a stimulus object and those of a consumer. Besides this, involvement has also been determined as a specific kind of reaction pattern, for example, as a specific kind of information processing hierarchy" (1994: 8-9).

The object of involvement can be not only the product (Kassarjian & Kassarjian, 1979) and the purchase decision (Engel & Blackwell, 1982), but it can relate to product advertising (O' Donohoe, 1992; O' Donohoe & Tynan, 1997) and be applied to areas such as consumer services (McColl-Kennedy & Fetter, 2001) or impulse purchasing (Rook & Fisher, 1995). In many consumer behavior studies, level of involvement is assigned either as a personality characteristic of the individual toward a product or to the product categories themselves and often relate to the time investment involved I n the choice decision, and includes the social risk of using or not using a product, and the financial risk relative to one's ability to pay for the product. In that context, a product that is deemed to be a low-involvement choice is one for which the individual does not consider the choice decision to be important enough to his other belief system to warrant extensive effort in the decision-making process. For example, a product is labeled as being of "low involvement" if the process to search for information about it is minimal, if there are no distinct brand loyalties for the product, and if a lower price for a competing brand leads to a choice decision based solely on cost (e.g., copy paper, paper clips, and light bulbs). Conversely, a "high-involvement"

product is one for which the consumer invests substantial time and effort prior to making a choice decision (e.g., automobiles, homes, vacations). In this respect, involvement is examined within the behavioral process, incorporating the interaction of the cognitive set of the individual as well as the product under study and is not treated solely as a behavioral characteristic that is somewhat stable in a person's life, regardless of the situation and contextual variables presented.

Understanding the fundamental determinants of behavior has been a paramount goal for many theorists in the social and decision-making sciences. The underlying psychological assumption driving the linkage between intentions and behavior is that most human behavior is under volitional control (Ryan, 1970). Fishbein & Ajzen (1975) have defined intention as a" person's location on a subjective probability dimension involving a relation between himself some action". Intentions are the single best predictor of planned behavior and intentions are also an unbiased predictor of action (Bagozzi, Baumgartner, &Yi, 1989). The behavioral intention models have received robust support in numerous behavioral domains (Ajzen, 2001; Eagly & Chaiken, 1993) and are considered being some of the most widely applied theories in social psychology (greve, 2001). The behavioral intention (i.e., purchase intention), based on the Theory of Planned Behavior (TPB) (Ajzen, 1991), is basically determined by three factors: the attitude that the person holds toward engaging in the behavior (i.e., subjective norm), and the degree of control that the person feels he or she has over performing the behavior (i.e., perceived behavioral control). The first two factors reflect the perceived desirability of performing the behavior is personally controllable or not. These three factors predict intention and the ensuing predicts behavior.

Common sense logic would suggest that all consumers should be able to estimate the regular from the other two pieces of information. However, there are some important caveats. Specifically, consumers must consider the price to be a relevant variable that is important enough to demand the attention and cognitive resources required for processing it. Furthermore, consumers must be willing, able and motivated to expend the cognitive resources (albeit a small amount) needed to estimate the implied regular price. Consumers' willingness to engage in such a process is likely to be a function of whether the additional information is central to the task at hand. If the available price information (particularly the additional and seemingly redundant comparative price information) is not deemed to be relevant, then consumers may not attend to this information. Therefore, consumers' choice of information processing strategy is directly related to their motivations and perceived relevance, that is, involvement. This construct has been defined in the literature as consumers' interest in and perceived importance/relevance of the advertised product (Celsi & Olson, 1988; Petty, Cacioppo & Schumann, 1983; Zaichkowsky, 1985).

2. Methodology:

The study was focused on finding out the reasons of consumers' involvement during their purchase decisions and the due to this involvement, what intentions are emerging out in the consumers for a repeat purchase? In order to this, the focus was drawn to identify the important variables and extracting out the relationships among these found variables how they are playing an effect on the problem of the study? The emphasis was to conduct a consumer-based survey that would be yielding the knowledge, perceptions and attitudes of consumers while they are making purchase decisions.

3. Theoretical Framework:

For conducting such research, the emphases was to identify the important variables that would be playing a vital role in creating the brand loyalty in the consumers' minds and have a strong relationship with the company and product. During literature survey, many variables were identified and found as the important for the study that leads consumers to purchase the product again and again. While designing the linkages and relationships among these variables, a comprehensive theoretical framework was designed that would be eliciting the required appetite for the study.

The conceptual model suggests whenever consumers are provided some motivational elements to purchase a product they will be more intended to purchase the product. Similarly, when they are provided high convenience in the product purchase decision, they will be more involved in the purchase decision. The model also suggests that companies should work a lot in order to provide a handy awareness to the consumers so that they can be more involved in product adoption. The consumers feel happy and pleased if they are tended to provide information regarding product and company through hi-tech like the internet because they can be aware of the features and varieties provided by the company in the business portfolio they are offering. It helps the consumers to purchase the product either through the net or, at least, they can be aware of the product. Whenever a company is performing such activities, they are trying to develop a strong and healthy bond with consumers. Such activities through which a company can develop a strong bonding with

consumers are known as relationship marketing. So, these activities help the company to develop a strong relationship with consumers. This all leads to develop a brand loyalty in the consumers' minds. As they become loyal to the product and company, they become more willing to use and adopt the product again and again. This phenomenon helps the organizations to develop a trust and a level of satisfaction in consumers yielding them to make them the clients of the company. But in order to this, the company has to commodize the product as well as they would have to personalize the products as much as possible on the basis of consumers' needs. This will be leading to make consumers choosier and more involved in the product they are purchasing. This will be demanding more efforts put by the company so as to satisfy these differentiated and varied needs of consumers in the form of more product quality and more product differentiation.

Sometimes, companies don't focus on the consumers' needs identification; rather they work on the creation of the needs in the consumers' minds. In order to do this, the companies have to innovate new and emerging ideas in the market so as consumers would be feeling the product they are using is new and innovative. The elite (quality conscious) class of every society always demands unique and competitive brands because they are trend setters and they want to innovate the market. To satisfy such people in the market, the companies have to develop new, unique and qualitative products for them. Once an image of the product has been generated in the market, it works in the same fashion in the market during whole its life cycle. This model focuses on the same innovation, product inventions and due to these, purchase intentions developing in consumers towards the products.

The model also argues that the companies would have to train the consumers about the product usage so as they can get the maximum advantage and benefits of the product for which they are making this purchase decision. In other words, the model claims that the companies should design such programs so as they can be prepared for having the maximum advantage from the product they are manufacturing. Because once consumers would be prepared for product purchase, ultimately the company will be in the position to achieve their ultimate objective, profit maximization. Whenever, consumers are trained and educated about the innovations and new products launched in the market, obviously, it will be leading to make them (consumers) more socialized, well-mannered and well-developed people in the society. This will be helping in developing positive social norms in the society and there will be more development in the society. This will be leading to make the individuals developed and courteous with their fellows, colleagues, life partners, and other society members. When consumers feel proud by using new and innovative products, they tend to be more positive to the society and feel more satisfied with their lives, yielding a positive attitude to the society. This all will be helpful in determining the strong, positive, and well-social culture in the society.

On the basis of above-mentioned discussion, the study is yielding a positive trend about consumers' involvement and their purchase intentions towards products in the context of relationships the companies are building with their consumers through providing them the highest level of satisfaction and with increasing the level of brand loyalty. The model contains three basic domains: Firstly, developing a positive and strong relationship with the consumers, secondly, increasing the level of brand loyalty in the minds of consumers through developing the level of satisfaction, trust, motivation to product purchase, brand commodization, product differentiation, product innovation, and product involvement, thirdly, development of society through making consumers learned, educated and socialized by usage of the products or services.

Ultimately, this model emphasizes on the societal development through developing such attitudes of consumers through which they can be well-off in the society and creating such culture that has a strong, positive and committed values that would be yielding positive social roles of the people in the society. This model focuses how the companies can play a role in developing a strong and positive culture and social norms by using the relationship marketing activities in that very society. Through this model, it is clear that the companies play a very dominant role in the society to make them well-off (Appendix A).

4. Research Design:

This study is hypothesis testing within which some hypotheses were designed and hypothetical means were used to prove these hypotheses statements. The settings for the study were considered as non-contrived within which a survey was conducted by consumers (households and employees). The unit of analysis for this study was individual in which every consumer had his/her own idea regarding the questions asked by them. Moreover, the data was collected on the longitudinal bases in which the data was collected once in the time span.

5. Data collection:

A questionnaire was designed to elicit the required information consisting of questions

pertaining to the important variables. Some questions were focused on the society development, cultural norms. Some questions of the questionnaire were asked to reveal information about the consumer learning about the product and company. Some questions were focusing the area of the relationship between company and consumers. The questionnaire was consisting of multiple choice and dichotomous questions mostly in order to make it plausible and feasible for consumers to answer accurately. A survey was conducted on a sample of 148 respondents and their responses were used for analysis to draw a valid conclusion. The sample was selected by the simple random sampling technique with every consumer was having the equal chances for occurring in the sample size.

6. Hypotheses Development:

On the basis of the relationships among the variables found in the literature survey important to the research problem, some hypotheses statements were conjectured and by using the data, the hypotheses were proved or rejected.

H1: If Buying motives are provided to the consumers then their behavior towards purchase will be strong.

During the literature survey, it was found when consumers are provided a set of benefits by the products, their intensity to purchase the products is increased. Obviously, we purchase the products for satisfying our needs and wants. These needs are basically the problems faced by individuals in their daily lives and in fact, they don't purchase the products for fun rather they purchase to solve these problems emerging out as their needs and wants. So, if companies try to increase their sales and market share, they would be tending to provide the satisfaction of needs of consumers through their products/services so as they can purchase them in abundance.

H2: If more convenience is provided to the consumers while purchase they will be more involved in the product purchase.

As technological development is emerging in the world, the people dislike wasting their time and resources for traveling to the product availability counter rather they consider product would be available on their doorstep where they can easily adopt and use it. It increases the efforts of companies to satisfy the kings (consumers) by performing supply chain management efficiently and would be providing the products at the place from where he/she can easily purchase it and satisfy its need.

H3: If consumers are well aware of the product and its functioning, then they will be more involved in the purchase decision of the product.

When consumers are going to adopt an innovative kind of product, they are not in the position to use that efficiently and can have the benefit in the best manner as could be taken if they are not aware of product's features and a good demonstration of the product is not provided to them. This would be yielding to clarify the importance of providing necessary and important information about the product to the consumers because if the product's features and its functioning is not made clear, the consumers don't feel it easier to use them in the best and efficient manner.

H4: If the behavior of the consumers is strong, then they will be more intended to purchase the product.

The hypothesis focuses on the fact that consumers will always feel happy and pleased whenever they feel positive about the product they are going to purchase. This reveals whenever consumers feel satisfaction and enjoyment from the product, they are more tended toward product purchase. This will be developing another important phenomenon that companies should work for developing the positive behavior of consumers toward their product through efficient and effective marketing campaign.

H5: If consumers are more emotionally attached to the product, then they will be more intended to purchase the product.

In order to make consumers convinced to the product purchase, the companies would have to design such marketing activities through which consumers would be feeling a higher level of attraction in that product and they would be tending to buy the same product. But this would be done only with the emphasis that the companies would be manufacturing the products as consumers need the product and according to their wants in the society. Once, consumers feel the satisfaction of their needs and want, they feel the product is good and at that time, the consumers feel that the product is satisfying their psychological needs as well as their physiological needs. This will be yielding the fact that consumers will be attached to the product psychologically and emotionally. Once, the consumers are emotionally attached to the product, they feel that the product is satisfying the best and they are more involved in purchasing that product.

H6: If consumers are well aware of the product, then they will feel more enjoyment while shopping the product.

Obviously, when consumers are clarified about the product and its usage, the consumers feel easier to purchase the product because they know each and every aspect of all features of the product they are going to purchase. This will be tending to make them more involved in the shopping of such products. This will be leading them to feel more easy, relaxed, confident, and cool while purchasing such products because whenever we purchase any product, we feel ourselves dizzy, confused and little bit ambiguous regarding that decision but by having a clear-cut information about the product and its usage, we feel easy and relaxed while purchasing the same product.

H7: If there will be more consumer relations proneness, then there will be strong effects of the relationship marketing by the company.

Whenever consumers purchase any product, they come in the position to have a strong bond or relationship with the company because whenever they will be feeling any problem with the problem, they will be contacting the company to get that problem solved. In such situations, the consumers are tending to make this relationship more and more strengthened. For that, they require company would be performing such activities through which they feel that company is with them whenever any problem arises and is trying to solve that problem without making consumers dizzy.

H8: If there is more interactivity between consumers and the company, then it will be leading towards strong effects of relationship marketing by the company.

The whole effort a company is performing creates no effect on the consumers except a strong and divergent kind of effect on consumers' attitude and perception regarding the product company is presenting to them. This may be in the form of product purchase repetition, brand loyalty, company preference etc. this all will be due to an interactivity created by a company with the consumers. This means how much intense this interactivity; the strong will be the relationship between company and consumers. This all is due to the relationship marketing activities performed by the company to attract the consumers towards it.

H9: If strong relationship marketing efforts performed by the company, then it will be leading to strong commitment owned by the company.

Whenever a company is focusing on the consumers' satisfaction and their needs' fulfillment, they would have to perform the highest level of relationship marketing campaign. Ultimately, the consumers will feel more pleased and satisfied with the products offered by the company. But once consumers are provided the highest level of satisfaction, they will be having an image of the company in the same manner and will be thinking to perceive the product in the same fashion and company has to perform the same marketing campaign in the same fashion for ever so as to keep consumers with it. So, the company has to own a strong commitment for ever to satisfy its consumers in the same way as has been done the first time.

H10: If strong relationship commitment exists between company and consumers, then it will be causing to increase more brand loyalty of the consumers.

Obviously, when a company argues they will be playing in the same fashion forever in the market and will be satisfying their consumers whenever they will be purchasing the product of the company, the consumers tend to be brand loyal to the company and try to purchase the similar brand again and again. If one thing is working, there is no need to change that and to switch to others. So, consumers always tend to purchase the product whenever they need that one.

H11: If there will be more brand loyalty in the consumers, then consumers will be more willing to use the product.

Consequently, when consumers become loyal to the product or a specific brand, they seldom try to shift to some other product because when they feel the product is satisfying their needs in the best manner, they don't even think of switching to some other product and they will be intended to purchase the product more frequently and repeatedly.

H12: If high E-Commerce tactics are adopted by the company, then it will be leading to develop strong Electronic Customer Relations Management.

The companies are making it easier and easier for the consumers to make them committed to their products and try to provide them more and more convenience during their purchase decision. In this, consumers demand that they have no time to go for window shopping and they don't want to spend even a single moment for the product inspection physically and they want that the address and place which they are mentioning to the company, the product would be made available at that place in the shorter span of time. The companies seldom try to make their consumers furious and angry. So, they try to provide the most of the company and product information online via internet and try to convince the consumers if they order via the net, the product would be made available at their doorstep in a very shorter span of time. The consumers have to move nowhere even not

for physically inspecting the product. The companies' exhibit their products in the catalogs provided at their websites established for such consumers. This all is known as customer relations management electronically or electronic customer relations management.

H13: If companies want to provide more commodization among brands to the consumers, then they would have to create high segmentation for the brands.

The companies try to make commodized products as much as possible because the needs of the consumers vary on the basis of their characteristics they possess. This demands the companies to make the company vulnerable and to be in a try of satisfying the varying needs of almost every group of consumers. This would be yielding the companies to make the clear and distinct groups of the consumers on the basis of their needs and wants, physiological and psychological characteristics they possess, along with the cultural and social elements within which society they live. So, when the companies are trying to commodize the products, they would have to segment the market with full extent.

H14: If companies provide more extrinsic benefits to the consumers, then it will be leading to create more intrinsic motivation among consumers for purchasing the product.

Every consumer contains his/her own set of needs, characteristics, and norms according to which they tend to make the purchase decision. The companies try to influence their purchase decisions by providing them more and more benefits. Sometimes, these influences are in the shape of the best features provided to them in the product, sometimes in the form of monetary discounts, and sometimes, in the form of unitary allowances. In short, the major emphasis behind this all scene is to influence the purchase decision of consumers and try to switch their purchase intentions towards company's products. These all tactics create a permanent and positive place in the consumers' minds and consumers feel intended to consider the company's products even he/she is purchasing some other brand.

H15: If consumers will be more involved in the products, then they show high cognition for the purchase decision of the product.

Whenever the companies put such efforts to create motivation in the consumers' minds, they are tended to purchase the products. Similarly, when they are more intended for a specific product, they feel more loyalty and commitment to that product. Consequently, they feel more involved in that product and concentrate that one while making a purchase decision of such product category. This concentration leads them to have high cognition in the product itself, its features, its functioning, and its competitiveness in the market. This makes the consumers more learned and trained for that product category and they tend to be more concentrated and involved. This high learning, concentration and cognition of consumers regarding some product category make them more educated, socialized and civilized.

H16: If consumers are more learned about the product, then they create a positive image of the product in their minds.

Whenever consumers get a level of information and education about a product, this would help develop a positive/negative reputation of the product in their minds. Every company wants to develop such position in their minds that would help the organization move towards the objective achievement (profit maximization) and this image/position can only be achieved with the help of strong efforts exerted by the company to develop this positive image in consumers' minds. So, ultimately, whenever consumers get more and more information about the product, they can clearly discriminate the good and poor products and can be in the position to accept/reject the product of the company. In order to attain this positive image in the consumers' minds, the companies would provide the products of the best quality that would be having a lasting impact on the consumers' minds and they can feel easy, relaxed and confident while purchasing that product.

7. Data Analysis & Data Interpretation:

In order to analyze the data that were collected from 148 respondents as a sample of the population drawn from the probability sampling via simple random sample method, we used the statistical program SPSS. The data was tabulated and this tabulated data was put in the SPSS program and the bivariate correlation (Pearson Correlation) analysis was conducted for all hypotheses statements mentioned above. The program enabled us to draw the valid conclusion there from the data collected from the respondents.

For hypothesis 1, the data analysis exhibited if consumers are provided some motivational elements, then there are chances of the positive and strong behavior of the consumers towards the product purchase and they will be tending to purchase the product. The following correlation matrix exhibits the results drawn from the computerized program and this reveals that hypothesis 1 is a valid statement during development an involvement level of the consumers towards a product.

Table 1: *Pearson correlation for H1*

		basic motivating element	consumer behavior
basic motivating element	Pearson Correlation	1	.119
	Sig. (2-tailed)		.149
	N	148	148
consumer behavior	Pearson Correlation	.119	1
	Sig. (2-tailed)	.149	
	N	148	148

For hypothesis 2, the results show that the people don't consider convenience as a very important factor while purchasing the product.

As in the following correlation matrix exhibits the afore-mentioned statement in a way that the Pearson Correlation is 0.005 which is not too large. This reveals that people consider convenience while shopping but don't put too much importance that they would be accepting/rejecting the product on this criterion. This depicts that consumers want convenience while shopping but for most instances if they would have to search for a specific product, they may do and would be purchasing the product that would be satisfying them the best.

Table 2: *Pearson correlation for H2*

		convenience shopping	consumer involvement
convenience shopping	Pearson Correlation	1	.005
	Sig. (2-tailed)		.956
	N	148	148
consumer involvement	Pearson Correlation	.005	1
	Sig. (2-tailed)	.956	
	N	148	148

For hypothesis 3, the results provide us the fact that customer awareness plays a negative role in the consumer involvement process. The results depict when consumers become aware of the product, they tend to leave the important and they become reluctant to the product purchase. This reveals the fact that consumers become aware of the product's features and drawbacks which lead them to adopt some other product that is error free and can satisfy their needs efficiently without leaving any problem. So, this hypothesis may not be accepted to our research problem.

Table 3: *Pearson correlation for H3*

		customer awareness	consumer involvement
customer awareness	Pearson Correlation	1	-.004
	Sig. (2-tailed)		.966
	N	148	148
consumer involvement	Pearson Correlation	-.004	1
	Sig. (2-tailed)	.966	
	N	148	148

For hypothesis 4, the results indicate that consumer behavior is linked with the motivation towards a product they are willing to purchase. This means when their behavior is positive to the product, they feel motivated and committed to the product purchase and their intentions are directed to the product leaving all other products of the industry a side. The companies would try to develop the strong behavior of the people to the product. By this, we mean that the companies would try their best efforts to develop the best image of the product in the consumers' minds in order to make them think positively about the product they are adopting.

Table 4: *Pearson correlation for H4*

		consumer behavior	customer motivation
consumer behavior	Pearson Correlation	1	.095
	Sig. (2-tailed)		.250
	N	148	148
customer motivation	Pearson Correlation	.095	1
	Sig. (2-tailed)	.250	
	N	148	148

Moreover, the results for hypothesis 5 indicate that the relationship between emotional attachment of the consumers with a product and the motivation of the consumers to purchase the same product is positive. This depicts when consumers feel that product is affecting their psychological characteristics, they feel more intended to purchase the product. This hypothesis and its results indicate that the companies should focus on the psychological needs of the consumers along with their physiological needs. The product is a set of the features used by the company to satisfy the Physiological needs of the consumers over which companies put a lot of efforts. But this hypothesis reveals that consumers tend to purchase the product if that is satisfying their psychological needs along with physiological needs.

Table 5: *Pearson correlation for H5*

		emotional attachment	customer motivation
emotional attachment	Pearson Correlation	1	.145
	Sig. (2-tailed)		.079
	N	148	148
customer motivation	Pearson Correlation	.145	1
	Sig. (2-tailed)	.079	
	N	148	148

The following table indicates correlation matrix between the awareness consumers have about a specific product and the fun, enjoyment and entertainment they feel while purchasing that product (hypothesis 6). The matrix shows a positive relationship between these two variables. This indicates when consumers know each and every aspect/feature of the product; they feel easier, relaxed and confident while making a purchase decision. Whenever consumers make a purchase decision, they make it under their cognitive process they use during this decision. The results indicate the same phenomenon that consumers feel happier, relaxed and confident during making such decision. So, the companies would try to make them more and more aware of the product features and their functioning because once they would be knowing all the features, they would be more in the position to decide what they need or what they don't need?

Table 6: *Pearson correlation for H6*

		customer awareness	shopping as entertainment
customer awareness	Pearson Correlation	1	.153
	Sig. (2-tailed)		.064
	N	148	148
shopping as entertainment	Pearson Correlation	.153	1
	Sig. (2-tailed)	.064	
	N	148	148

From the result of correlation matrix explaining the hypothesis 7, it is clear that the relationship between customer interactivity and relationship marketing is positive and strong. This depicts whenever customers purchase the products, in fact, they are developing a bond/relationship with the company which has been established only when they purchase the products. This relationship becomes strengthened when consumers purchase the product and feel satisfaction from that very product. So, the companies would try to perform such activities through which consumers feel that the purchase decision has enabled them to have a strong relationship with the company.

Table 7: *Pearson correlation for H7*

		customer interactivity	strong relationship
customer interactivity	Pearson Correlation	1	.099
	Sig. (2-tailed)		.230
	N	148	148
strong relationship	Pearson Correlation	.099	1
	Sig. (2-tailed)	.230	
	N	148	148

The following matrix reveals the facts drawn from hypothesis 8 whenever consumers interact with the company whether in the shape of information gathering, advertisement watching, product purchasing product etc., only then they become in the position to have a strong relationship with the company because whenever they come to know about the product and company, only then, they feel themselves in the position to interact with company positively in the shape of product purchasing. The correlation matrix between customer interactivity and strong relationship depicts that there exists a positive relationship between these two variables. This means whenever consumers will be interacting with the company, only then the relationship between company and consumers will be strong. This means that companies would definitely focus on to make the consumers interacted with the company through any means whether in the shape of product awareness, product visibility, product service or product purchase. Once, they will be interacted with the company through effective relationship marketing activities, only then, they will be motivated to purchase the product again and again and will be loyal to the company and product.

The correlation matrix for H9 depicts that relationship between company and consumers and commitment owned by the company to develop that relationship is positive. This result indicates that the company would have to be committed to establishing a strong relationship between company and consumers so as consumers would be fully satisfied and would be becoming loyal to the product purchase and adoption. This also depicts when a company wants to have the highest level of market share, they would have to develop a strong and positive relationship between company and consumers. Once, this relationship is established, and then consumers

will be more and more satisfied to the product and company leading to make them loyal and involved to the purchase decision again and again. So, H9 is accepted.

Table 9: *Pearson correlation for H9*

		company-customer relationship	customer commitment
company-customer relationship	Pearson Correlation	1	.018
	Sig. (2-tailed)		.825
	N	148	148
Customer commitment	Pearson Correlation	.018	1
	Sig. (2-tailed)	.825	
	N	148	148

The following correlation matrix exhibits the results of H10 and depicts that the relationship between company-customer relationships and the brand loyalty is positive. This means whenever company focuses on establishing strong relationships with their customers, the customers feel it more attracted and they become loyal and committed to the company as well as the product they are purchasing. Their intentions towards product purchase increase with the positive relationship established by the company. This means whenever a company wants its customers as repeat purchasers, the company would have to develop positive relations with them and would provide them lots of incentives to make them loyal and committed to the company and product. This means H10 of the model is acceptable.

Table 10: *Pearson correlation for H10*

		company-customer relationship	brand loyalty
company-customer relationship	Pearson Correlation	1	.078
	Sig. (2-tailed)		.345
	N	148	148
brand loyalty	Pearson Correlation	.078	1
	Sig. (2-tailed)	.345	
	N	148	148

The following correlation matrix exhibits the results drawn from H11 that show the positive relationship between the brand loyalty of the consumers and their willingness to purchase and adopt the product. These results indicate when consumers become more loyal to the product and company, they tend to be more willing to purchase and adopt the same product frequently and repeatedly. They don't want to switch to other products frequently and want to remain with the same product whatever the situation would be; they would be in the search of that same product whenever they would be feeling them in the need of that product. So, results suggest accepting H11.

Table 11: Pearson correlation for H11

		brand loyalty	product usage
brand loyalty	Pearson Correlation	1	.056
	Sig. (2-tailed)		.496
	N	148	148
product usage	Pearson Correlation	.056	1
	Sig. (2-tailed)	.496	
	N	148	148

The results of H12 indicate consumers get knowledge and awareness from the internet while they are in cognition for product purchase decision but they want to purchase the product physically because they don't consider the internet a reliable source for inspecting and checking the product. They consider when any product is to be purchased, it would be done after physically examining and inspecting the product because they feel the product's features would be examining first before purchasing the product. So, this indicates the negative relationship of internet and internet shopping. This means that consumers are reluctant to purchase the products via the internet. So, results suggest rejecting H12.

Table 12: *Pearson correlation for H12*

		the role of the internet in consumer involvement	internet shopping
Role of internet in consumer involvement	Pearson Correlation	1	-.064
	Sig. (2-tailed)		.443
	N	148	148
internet shopping	Pearson Correlation	-.064	1
	Sig. (2-tailed)	.443	
	N	148	148

The results of H13 depict whenever companies try to provide the highest level of satisfaction to almost every individual of the market, they would have to develop many features in the products and

They would have to divide the total market into many segments so as they could be easily distinguished and characterized. In order to provide them the highest level of satisfaction, the company has to focus on their needs and wants and as they need or want, the companies would produce the products in the same manner. In order to do so, the companies have to make a decision about the segments of the consumers they can easily satisfy. By doing the same, the companies can narrower down their work responsibilities through which they can efficiently achieve their target, the highest level of satisfaction of consumers.

The following correlation matrix exhibits there exists a positive relationship between product commodization and market segmentation

Table 13: *Pearson correlation for H13*

		product commodization	product personali-zation
product commodization	Pearson Correlation	1	.207(*)
	Sig. (2-tailed)		.012
	N	148	148
product personalization	Pearson Correlation	.207(*)	1
	Sig. (2-tailed)	.012	
	N	148	148

The results of hypothesis 14 indicate that every individual works here for the sake of his/her benefits he/she is attaining. So, when they are considering any product to purchase, that would also be basing over benefits provided by the company through their product/service. This means how much efficient the product and its features will be, the more chances there would be for the product to be accepted by the majority of the market. This suggests that companies would work a lot to provide lots of extrinsic benefits to consumers when they purchase the product in order to make them attracted and committed to the product and company.

The following correlation matrix indicates the results of hypothesis 15 showing the fact whenever consumers are widely involved in the product and it's functioning, they tend to know a lot about the features of the product, the services provided by the product, and functioning of product features. This means there is a strong positive relationship between consumers' involvement and their learning about the product. This means the companies would tend to make their consumers more and more involved to the product and its features while producing that very product so as they would be knowing a lot about product and its features' functioning

Table 15: *Pearson correlation for H15*

		consumer involvement	product learning
consumer involvement	Pearson Correlation	1	.155
	Sig. (2-tailed)		.060
	N	148	148
product learning	Pearson Correlation	.155	1
	Sig. (2-tailed)	.060	
	N	148	148

The results of hypothesis 16 are exhibited by the following correlation matrix that indicates when consumers become more learned about product, its features, and their functioning, the position of the product in their minds takes place at a reasonable place from where they think that product is valuable and the value of the product in consumers' minds increases after their learning about the product whatever the source of that learning would be whether through word of mouth, advertisements, articles in journals and magazines etc.

		product learning	product repute
product learning	Pearson Correlation	1	.346(**)
	Sig. (2-tailed)		.000
	N	148	148
product repute	Pearson Correlation	.346(**)	1
	Sig. (2-tailed)	.000	
	N	148	148

8. Findings & Conclusions:

From all the research the done and on the basis of analysis and evaluation of the data, we reached the conclusion that the companies would have to work a lot for creating the involvement in the minds of the consumers if they want that the sales of the companies would be reaching at the top in the industry. For that, the companies would have to create and develop the brand loyalty in the consumers so as to make them the repeat customers. If the customers try to be the repeat customers, they would have to have a prior knowledge about the company and its developed products because if and only if customers would have been given awareness and knowledge, only then they

would be brand loyal to the company, otherwise it is very difficult for the company. The results and findings narrate that there exists a positive and strong relationship between the company and customers if the customers are well aware and educated about the company and its products.

So, the companies would try to focus on the relationship building with the customers to the highest extent

they want that their market share and sales would be increased in the industry. For that, they would have to design such marketing campaigns and such marketing efforts would be performed that would be yielding the companies to get the highest market share and making them the best in the universe and market.

The companies would be enabling the customers to clearly differentiate the products in the stores so as they can easily assess the best product and can easily judge that whether the product can satisfy their needs and wants at the best or not. This can be done through developing the society and socialization in the market and let the customers be socialized through their learning and education in the market and consider them the difference between the best-in-class product and other remaining products of the industry. The results suggest that the companies would make it sure that the customers would be having the best awareness and would be having a positive relationship with the company so as they can become the brand and company loyal and can purchase the products repeatedly.

Corresponding Author:
Muhammad Nadeem,
Faculty of Management, National University of Modern Languages, Pakistan.
E-mail: muhammadnadeem19@gmail.com

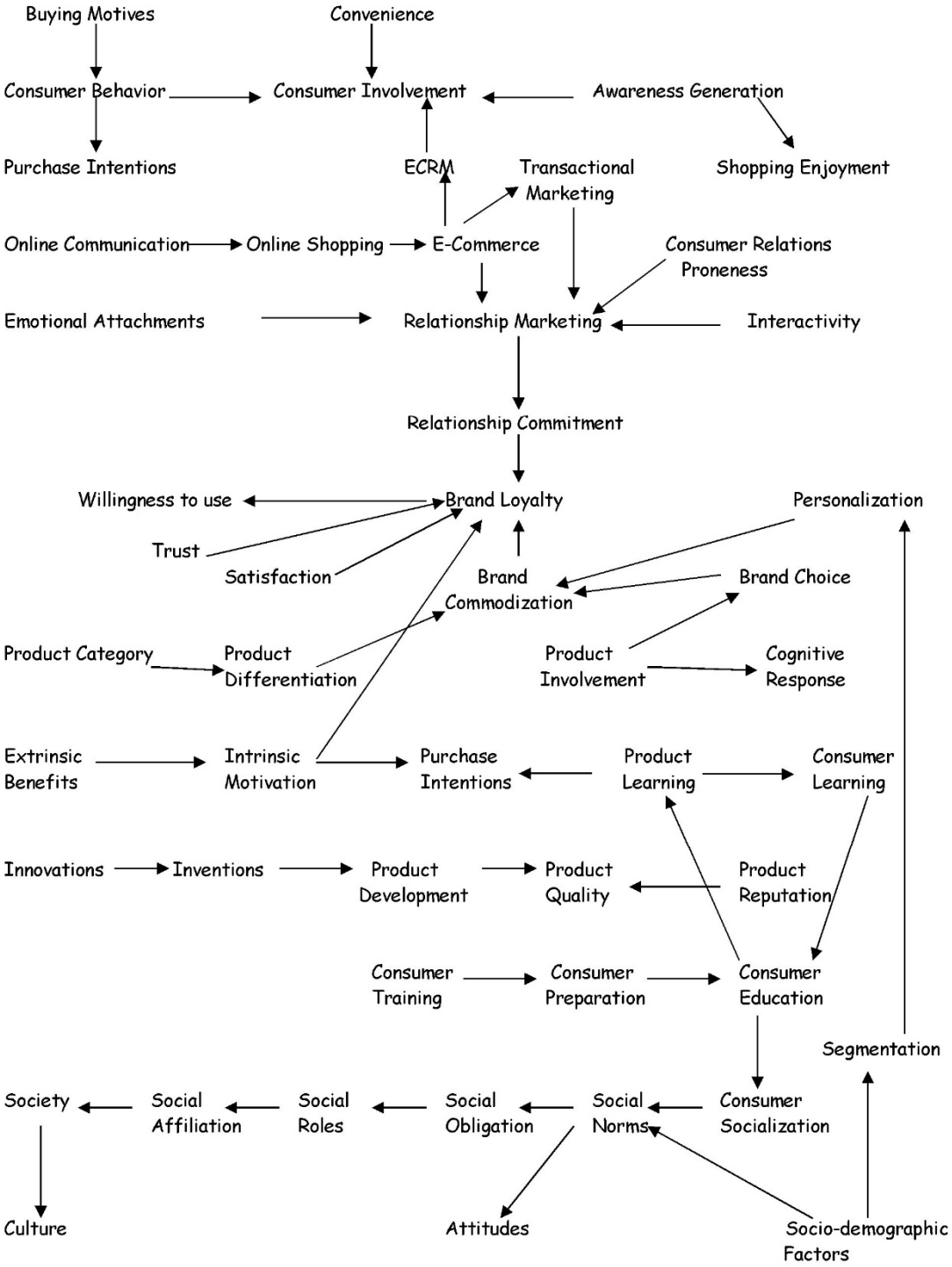
References

1- Bell, R., & Marshall, D. W. (2003). The construct of food involvement in behavioral research: scale development and validation. *Appetite*, 40(3), 235-244.
2- Olsen, S. O. (2001). Consumer involvement in seafood as family meals in Norway: an application of the expectancy-value approach. *Appetite*, 36(2), 173-186.
3- Chen, M. F. (2007). Consumer attitudes and purchase intentions in relation to organic foods in Taiwan: Moderating effects of food-related personality traits. *Food Quality and Preference*, 18(7), 1008-1021.
4- Chandrashekaran, R. (2004). The influence of redundant comparison prices and other price presentation formats on consumers' evaluations and purchase intentions. *Journal of Retailing*, 80(1), 53-66.
5- Dussart, C. (2001). The transformative power of e-business over consumer brands. *European Management Journal*, 19(6), 629-637.
6- Paterson, C. (2004). 'Take small steps to go a long way' consumer involvement in research into complementary and alternative therapies. *Complementary Therapies in Nursing and Midwifery*, 10(3), 150-161.
7- Dijkstra, M., Buijtels, H. E., & van Raaij, W. F. (2005). Separate and joint effects of medium type on consumer responses: a comparison of television, print, and the Internet. *Journal of Business Research,* 58(3), 377-386.
8- Lockshin, L., Jarvis, W., d'Hauteville, F., & Perrouty, J. P. (2006). Using simulations from discrete choice experiments to measure consumer sensitivity to brand, region, price, and awards in wine choice. *Food quality and preference,* 17(3), 166-178.
9- Candel, M. J. (2001). Consumers' convenience orientation towards meal preparation: conceptualization and measurement. *Appetite*, 36(1), 15-28.
10- Bennet, R., Hartel, C. J. H., & McColl-Kennedy, J. R. (2005). Experience as a moderator of involvement and satisfaction on brand loyalty in a business-to-business settings. *Industrial Marketing Management,* 34(1), 97-107.
11- Lockshin, L. S., Spawton, A. L., & Macintosh, G. (1997). Using product, brand and purchasing involvement for retail segmentation. *Journal of Retailing and Consumer services*, 4(3), 171-183.
12- Repper, J., & Breeze, J. (2007). User and carer involvement in the training and education of health professionals: a review of the literature. *International journal of nursing studies*, 44(3), 511-519.
13- Park, D. H., & Lee, J. (2009). eWOM overload and its effect on consumer behavioral intention depending on consumer involvement. *Electronic Commerce Research and Applications*, 7(4), 386-398.
14- Lian, J. W., & Lin, T. M. (2008). Effects of consumer characteristics on their acceptance of online shopping: Comparisons among different product types. *Computers in Human Behavior*, 24(1), 48-65.
15- McWatters, K. H., Chinnan, M. S., Phillips, R. D., Walker, S. L., McCullough, S. E., Hashim, I. B., & Saalia, F. K. (2006). Consumer-guided development of a peanut butter tart: Implications for successful product development. *Food quality and preference*, 17(6), 505-512.

16- Boote, J., Barber, R., & Cooper, C. (2006). Principles and indicators of successful consumer involvement in NHS research: results of a Delphi study and subgroup analysis. *Health Policy*, 75(3), 280-297.
17- Bhate, S. (2005). An examination of the relative roles played by consumer behavior settings and levels of involvement in determining environmental behavior. *Journal of Retailing and Consumer Service*s, 12(6), 419-429.
18- Verbeke, W., Vermeir, I., & Brunsø, K. (2007). Consumer evaluation of fish quality as the basis for fish market segmentation. *Food Quality and Preference,* 18(4), 651-661.
19- Kim, J., Fiore, A. M., & Lee, H. H. (2007). Influences of online store perception, shopping enjoyment, and shopping involvement on consumer patronage behavior towards an online retailer. *Journal of retailing and Consumer Services*, 14(2), 95-107.
20- Odekerken-Schröder, G., De Wulf, K., & Schumacher, P. (2003). Strengthening outcomes of retailer–consumer relationships: The dual impact of relationship marketing tactics and consumer personality. *Journal of business research,* 56(3), 177-190.
21- Howard, P. B., Clark, J. J., Rayens, M. K., Hines-Martin, V., Weaver, P., & Littrell, R. (2001). Consumer satisfaction with services in a regional psychiatric hospital: A collaborative research project in Kentucky. *Archives of Psychiatric Nursing*, 15(1), 10-23.
22- Megehee, C. M. (2009). Advertising time expansion, compression, and cognitive processing influences on consumer acceptance of message and brand. *Journal of Business Research*, 62(4), 420-431.
23- Zhang, S., & Markman, A. B. (2001). Processing product unique features: Align ability and involvement in preference construction. *Journal of Consumer Psychology*, 11(1), 13-27.
24- Claeys, C., Swinnen, A., & Abeele, P. V. (1995). Consumer's means-end chains for “think” and “feel” products. *International Journal of Research in Marketing*, 12(3), 193-208.
25- Whelan, S., & Davies, G. (2006). Profiling consumers of own brands and national brands using human personality. *Journal of Retailing and Consumer Services*, 13(6), 393-402.
26- van Waterschoot, W., Sinha, P. K., Van Kenhove, P., & De Wulf, K. (2008). Consumer learning and its impact on store format selection. *Journal of Retailing and Consumer Services*, 15(3), 194-210.

Received February 04, 2016; February 20, 2016; accepted March 01, 2016; published online April 01, 2016.

Appendix A
Conceptual Framework



Assessing the Potential Impact of Garden Egg Germplasm on Egg Fruit and Shoot Borer (*Leucinodes orbonalis*) Infestation in Umudike

C. J. Harriman[1*] • C. A. Nwammadu[2]

[1]Department of Agronomy, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.
[2]Department of Crop Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria.
harrimanchidi@gmail.com

Abstract: The present investigation is carried out to study the performance of five garden egg cultivars against *Leucinodes orbonalis* Guenee in South-eastern agroecology of Nigeria in 2014 and 2015 cropping seasons at the National Root Crops Research Institute (NRCRI) Umudike, Research Farm. The trials were arranged in the Randomized Complete Block Design with five replicates and analyses were done by pooling over two years due to insignificant genotype X year interactions. Results of the study indicate significant variations amongst the cultivars for the agronomic and damage attributes. Lowest number of fruits (4.47) was damaged in Ngwa large (V_5). However, highest number of damaged fruits (10.30) was recorded in Sweet white (V_3). With respect to yield parameters, highest; fruit weight per plant and fruit yield were observed in Sweet white (V_3) with values of 1.19kg and 14.28t/ha respectively. Results from rank summation index (RSI) shows that Ngwa large (V_5) is the best performer with RSI value of 17. Fruit yield was significantly and positively correlated with number of branches per plant (r = 0.40*), number of fruit per plant (r = 1.00**), Plant height (r = 0.60*) and fruit weight per plant (r = 1.00**) and recorded negatively and non- significant relationships with number of damage fruit per plant (r = -0.30) and Percentage fruit damage per plant (r = -0.50).

To cite this article
[Harriman, C. J., & Nwammadu, C. A. (2016). Assessing the Potential Impact of Garden Egg Germplasm on Egg Fruit and Shoot Borer (*Leucinodes orbonalis*) Infestation in Umudike. *The Journal of Middle East and North Africa Sciences*, 2(4), 31-38]. (P-ISSN 2412- 9763) - (e-ISSN 2412-8937). www.jomenas.org. **4**

Keywords: *Leucinodes orbonalis*, cultivar, garden egg, resistant/tolerant, rank summation index.

1. Introduction

Eggplant (*Solanum melongena* (Linnaeus)) is one of the most important fruit and leafy vegetable widely cultivated in tropical Africa; probably the third after tomato and onion, and before okra (Grubben and Denton, 2004; Hanson *et al*., 2006). It belongs to the Solanaceae family, which includes crops such as tomatoes, potatoes and capsicums. Owing to the fact that eggplant is widely consumed on a daily basis especially in the forest zone, the crop represents a very important source of income for many rural and urban households (Danquah, 2000; Owusu- Ansah *et al*., 2001). It is known for its ability to provide large amounts of food from a small space. Also, the fruits have a storage life up to three months and can be dried and stored for later use, when the growing season is over and nothing fresh is available (NRC, 2006; Stone et al., 2011; National Research Council, 2006). The fruit is primarily used as a cooking vegetable for various dishes in different regions of the world. It has taken firm hold as a meat substitute and popular vegetarian dishes. The leaves and flowers of some varieties of eggplant are edible and may be added to soups and sauces. The fruits of eggplant can be eaten raw, cooked or fried (Tindal, 1992). Eggplant fruits provide protein, vitamins, and minerals but low in sodium, calories and fat. It contains a large quantity of water and good for balancing diets that are heavy in protein and starches. It is high in fibre and provides additional nutrients such as potassium, magnesium, folic acid, vitamin B6 and A (NRC, 2006). It is rich in reducing sugars, anthocyanin, phenols, glycoalkaloids, dry matter, and amide proteins (Bajaj *et al.,* 1979). Eggplant is good for diabetic patients and can be used to cure toothache. It has also been recommended as an excellent remedy for people suffering from liver complaints (Chen and Li, 1996).

All these benefits, coupled with higher yield and longer fruiting and harvesting period lure the farmer on eggplant production (Ghimire et al., 2007). However, eggplant production is under threat in recent years due to increased cost of production on management of insect pest complex. Eggplant fruit and shoot borer (EFSB), *Leucinodes orbonalis*

(Lepidoptera: Pyralidse) Guenee, is the key pest of eggplant (Chakraborti and Sarkar, 2011; Saimandir and Gopal, 2012) inflicting sizeable damage in almost all the eggplant growing areas (Dutta *et al.,* 2011) and is most destructive, especially in south Asia and Africa (Thapa, 2010) (Figure A - F). Patnaik (2000) for instance reported that *L. orbonalis* damage to fruit in the field ranges from 47.6 % to 85.8 % of harvest. As a result of its feeding inside fruit, the fruits become unmarketable and yield losses up to 90 percent (Baral, et al., 2006). If the caterpillars bore into shoots and stems, or there is a heavy infestation, this will weaken the host plant and cause yield loss in unaffected fruits. Hence, many farmers leaving growing eggplant because of this pest (Gapud and Canapi, 1994). The very high damage potential attributed to this pest is owed to its high reproductive capacity and rapid turnover of generations. It is also very difficult to control since it feeds inside the shoot and fruit. Synthetic chemicals have overtime provided competitive and effective tool in the battle against this pest.

Figure (A). *Leucinodes orbonalis*, live adult moth showing a typical resting posture with the abdomen curled up

Figure (B). Damage caused by *Leucinodes orbonalis* caterpillars boring into fruit

Figure (C). The larva/ Caterpillar of *L. orbonalis* causing shoot damage to garden egg stem

Figure (D). The larvae/ Caterpillar on garden egg leaf

Figure (E). Caterpillar of *Leucinodes orbonalis* on garden egg

Figure (F). Larvae of *L. orbonalis*

Their environmental and health hazards they constitute has been pointed out repeatedly. According to Horna et al. (2008), infestation by some of these pests significantly increases the probability that farmers would apply insecticides. Botwe et al. (2011) observed that some of these applications are done a day prior to harvest in order to obtain a good looking vegetable. Repeated application of insecticides at short intervals in disregard of pre-harvest intervals

however, exposes the environment, consumers and farmers to toxic residues that can persist even after processing (Bull, 1992) and also increases production costs and consequently, reduces profits from sale of produce. There is every possibility also that the frequent spraying and harvesting of the fruits does not consider the half-life. This makes it expedient to explore control measures that are safe, cheap and effective. The use of resistant cultivars is perhaps the most desirable method of controlling pests in this crop (Than *et al*., 2008).

This approach, according to Voorrips *et al.* (2004), has been less exploited in fruit and vegetable crops mainly due to the longer time required for breeding and selecting for resistance and the short term advantage of chemical control. In spite of this, host resistance is considered the most prudent means of pest control because of its effectiveness, ease of use, and lack of potential negative effects on the environment (Phoulivong, 2011). According to Chandha (1993), resistant varieties showed low fruit infestation. He believed that long narrow fruited variety suffered less because of low egg laying preference compared to short and wide fruited. Similarly, genotypes bearing thin fruits with short calyx and lower number of calyx with lower diameter and thin shoot are being considered tolerant to *L. orbonalis* attack (Malik et al., 1986). The anatomical characters such as more lignified hypodermis, compact vascular bundles and narrow shoot pith were less susceptible cultivars. Borer doesn't prefer light green fruits as they had narrow pericarp and mesocarp with compact seedlings and seeds closely arranged. Knowledge of varietal preference of eggplant shoot and fruit borer can play a significant role in the successful eggplant production and will provide information that might promote minimal use of insecticides and eventually lead to pesticide free production. Unfortunately, very limited efforts were given in this regards. Considering the above situation, the present research was conducted to screen out and identify insect pest resistant/tolerant eggplant variety for exploitation in crop improvement and which might also be an important tool for the management of this pest.

2. Materials and Methods:

The experiment was conducted at the National Root Crops Research Institute (NRCRI), Umudike situated at Latitude 05°28' N, Longitude 06°52'E and Altitude 122m above sea level in 2014 and 2015 cropping season. Umudike has a total rainfall of about 2000-2500mm per annum with annual average temperature of about 26^0C. The predominant vegetative type is rain forest (NEST, 1991). However, the soil was classified as sandy loam ultisol. The cultivars which were obtained from different localities in Southeastern Nigeria were raised in the nursery for 4weeks, and later transplanted and watered heavily in a plot area of 2m × 3m and replicated 5 times using a randomized complete block design. They include; Gauta Bello (V_1), Large green (V_2), Sweet white (V_3), Leafy eggplant (V_4) and Ngwa large (V_5). To raise the seedlings, clean healthy seeds of local variety were sown 3 cm apart and 1 cm deep in plastic trays (34 x 24 x 4 cm), giving a total of 60 seeds per tray. They were maintained following normal agronomic practices. A space of 0.5m was allowed between treatment plots and 1.0m was spaced between blocks. The seedlings were transplanted at 1 seedling per hill with spacing of 1 × 1m which gave plant population density of 10,000plants/ha. Weeding was done regularly and manually to reduce inter-species competition.

2.1. Insect sampling and scouting: Foliage insect pests sampling commenced two weeks after transplanting of seedlings and was undertaken between 7:00 and 10:00 am.

2.2. Assessment of percent shoot damage

Assessment of shoot damage by *L. orbonalis* was undertaken by closely examining four randomly selected plants in each genotype in each block for signs of *L. orbonalis* infestation (presence of frass or emergent holes on shoots as well as signs of drooping). The extent of damage both on shoot and fruit of different genotypes were calculated and expressed in percentage (Rahman *et al*., 2012). Data were collected at every 3 weeks interval started at 2 weeks after transplanting (WAT) and continued to till maturity. Percent shoot and fruit damage were calculated using following formulae;

$$\% \text{ Shoot damage} = \frac{\text{Number of damaged shoot}}{\text{Total number of shoot}} \times \frac{100\%}{1}$$

$$\% \text{ Fruit damage} = \frac{\text{Number of damaged fruit}}{\text{Total number of fruit}} \times \frac{100\%}{1}$$

2.3. Assessment of percent fruit infestation by L. orbonalis:

Mature fruits were harvested per plot and the fruits were sampled for EFSB infestation. All the fruits were examined by careful dissection and the infested ones separated from the un-infested ones. The number of infested fruits were counted and expressed as percentage of total number of fruits collected per plot per week. A hand lens and diagnostic manual for the identification of insect

pathogens published by Poinar and Thomas (1978) was used for confirmation of insect identity.

3. Results and Discussion:

The classification of a range of genetic variability among cultivars is pivotal to the maintenance and further acquisition of germplasm resources even as accessions from diverse origins are needed as parents stocks for the development of improved varieties (Aremu *et al*., 2007). The mean plant height, number of leaves, number of branches at 12 weeks after planting (WAP) and days to 50% flowering among the five cultivars differed significantly (Table 1). The tallest variety, Leafy eggplant (V_4) which was 80.4cm tall also had the highest number of leaves (131.7). However, Sweet white (V_3) which was the shortest variety (46.4 cm) had the highest number of branches (12.03). Gauta Bello (V_1) and Ngwa large (V_5) flowered on the 34.89th day after planting while leafy eggplant (V_4) flowered last (in 37.22 days).

This morphological variation may be due to genetic basis. The variation obtained on the days to 50% flowering is in agreement with Thomas and Vince-Prue (1997) who reported that many plants flower in response to seasonal changes in day length and that this response often varies between accessions of a single species base on their genetic constitution. According to Alejandro *et al*. (1998) this observation, along with the fact that these characteristics are expressed differently in individuals of different origin cultivated within the same home garden, suggests that such characteristics have an important genetic component. This would indicate then that changes in morphological characters may be inherited. The existence of high variability for different characters among garden egg varieties had been earlier reported by Ariyo (1993); Adeniji (2003) and Kale *et al*., (1986).

Table 1: *Agronomic traits variations of 5 garden egg cultivars*.

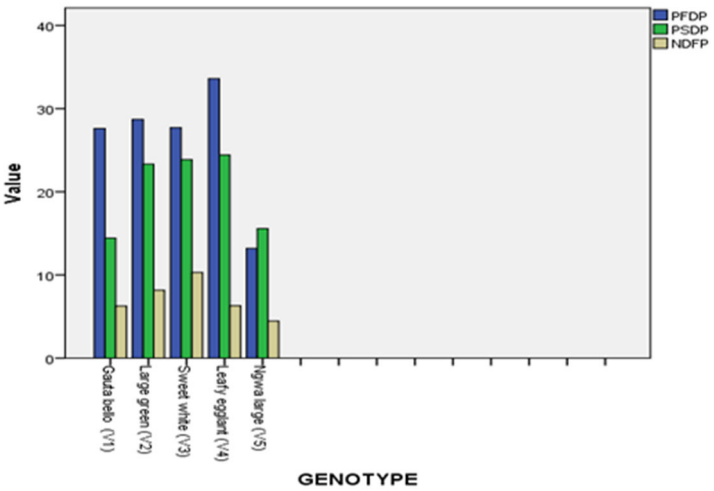
GENOTYPE	PH @ 12WAP	NL@ 12WAP	NB@ 12WAP	D50%F
Gauta bello (V1)	50.8	69.7	8.20	34.89
Large green (V2)	58.1	92.9	8.50	35.22
Sweet white (V3)	46.4	85.0	12.03	35.67
Leafy eggplant (V4)	80.4	131.7	9.80	37.22
Ngwa large (V5)	64.5	105.0	9.17	34.89
Mean	60.1	96.9	9.54	35.58
LSD $_{(0.05)}$	8.72	19.79	2.181	NS
CV (%)	2.1	6.0	9.2	10.5

PH = Plant height (cm), NL = Number of leaves,
NB= Number of branches, D50%F = Days to 50% flowering.

With respect to damage parameters, significant differences existed among the cultivars in their susceptibility to fruit borer attack (Table. 2). Shoot damage per plot was observed to be lowest (14.43%) in Gauta Bello (V_1) while the highest incidence (24.43%) was recorded in leafy eggplant (V_4). The results obtained from the number of damaged fruits per plant indicated that the lowest number of fruits (4.47) was damaged in Ngwa large (V_5). This was followed by Gauta Bello (V_1) that had 6.27 of its fruits damaged. However, highest number of damaged fruits (10.30) was recorded in Sweet white (V_3). With respect to percentage fruit damage per plant, least damage (13.2%) was observed in Ngwa large (V_5) while severe damage was recorded in leafy eggplant (V_4) which had 33.6% of its fruits damaged by *L. orbonalis*. In all, Ngwa large (V_5) was least affected by the three damage parameters (Figure. 1).

Figure (1). PFDP, PSDP, and NDFP of the five garden egg genotypes.
PFDP = Percentage fruit damage per plant (%),
PSDP = Percentage shoot damage (%) per plot, NDF/P = Number of damage fruit per plant.

The variations observed in relative susceptibility of different cultivars against *L.*



orbonalis may be attributed to multiplicity of mechanisms which influence the ultimate degree of plant damage by insect pests. Presence or absence of special substances and differing amounts of nutrients affects various gustatory responses of the insects. This view is in support of Kennedy (1995), who reported that nutrients may act as feeding stimulants or as co-factors and synergists to more specific stimulants and can play a dominant role in host selection, feeding and colonization by various insect species.

Table 2: *Yield and damage traits variations of 5 garden egg cultivars.*

GENOTYPE	NF/P	NDF/P	PFD/P (%)	PSD/P (%)	FW/P (kg)	FY(t/ha)
Gauta bello (V1)	23.10	6.27	27.6	14.43	0.633	7.60
Large green (V2)	28.03	8.17	28.7	23.33	0.797	9.56
Sweet white (V3)	37.23	10.30	27.7	23.87	1.190	14.28
Leafy eggplant (V4)	18.80	6.30	33.6	24.43	0.367	4.40
Ngwa large (V5)	33.77	4.47	13.2	15.57	0.900	10.80
Mean	28.19	7.10	26.2	20.33	0.777	9.33
LSD $_{(0.05)}$	3.974	2.524	8.05	4.601	0.2464	2.957
CV (%)	4.9	25.6	25.7	7.2	7.2	7.2

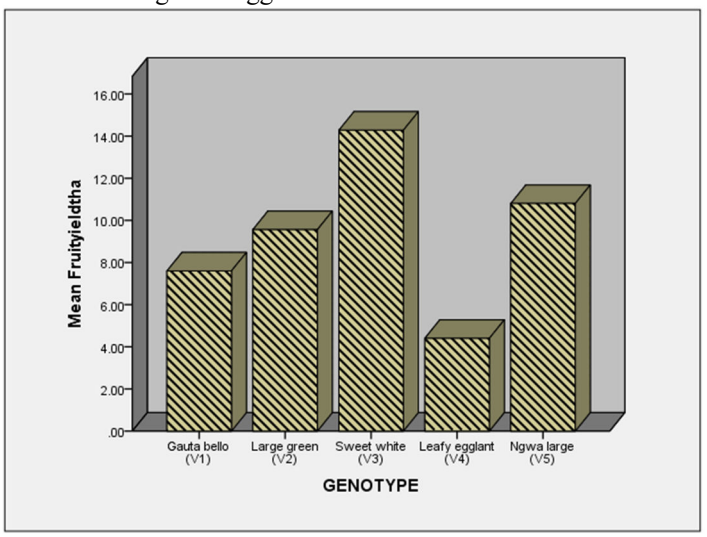
NF/P = Number of fruit per plant, NDF/P = Number of damage fruit per plant, PFD/P = Percentage fruit damage per plant (%), PSD/P = Percentage shoot damage (%) per plot, FW/P = Fruit weight per plant (kg), FY = Fruit yield per hectare (t/ha).

Martin (2004) in his study obtained the highest lignin content coupled with lowest shoot and fruit infestation in wild relatives of S. melongena. The anatomical characters such as more lignified hypodermis, compact vascular bundles tightly arranged seeds and narrow shoot pith were less susceptible cultivars. Lignin is a phenolic compound, which increases un-palatability of the food materials. Painter (1951) believed that relative susceptibility of different cultivars against *L. orbonalis* depends upon two factors, softness of shoot and fruit pulp and different intrinsic characters of tolerances.

It was reported that thick pubescence on the leaves made them least attractive to the adult moth (*L. orbonalis*) to deposit their eggs; also the newly hatched larvae cannot bore early in their fruit (Dadmal, 2004). On their studies Panda and Khush (1995) observed that varieties with characteristics like hair and prickle on stems, leaves and fruit stalks result in lowest percentage of fruit infestation as compared to those without hair and prickles. Harriman et al. (2014) argued that research of some morphic characters carried out with varieties with loose parenchyma cells in cortical region and thin cuticle collenchymatous area, with large spaces between vascular bundles were responsible for susceptibility of maize cultivars to stem borer.

With respect to yield parameters which recorded significant difference, highest; number of fruit per plant, fruit weight per plant and fruit yield were observed in Sweet white (V_3) with values of 37.23, 1.19kg and 14.28t/ha respectively. While the lowest value of 18.80, 0.367 kg and 4.40t/ha respectively was obtained in leafy eggplant (V4) (Figure. 2).

Figure (2). Fruit yield (t/ha) variation among the five evaluated garden egg cultivars.



This variation in yield could be attributed to genetic endowment of individual crop specie. Yield basically, it is determined by the expression and interaction of numerous genes which affect vital processes within the plant such as nutrition, photosynthesis, transpiration, translocation and storage of food materials. This observation is supported by Kumar (1999) who stated that yield is determined directly or indirectly by genes affecting maturity, disease and pest resistance. He maintained that variation within a crop specie are variation due to hereditary (genetic). Abdullah et al. (2003) reported that crop genotypes produce fruits of various sizes as dictated by the genetic constitution. According to Owusu-Ansah et al. (2001), major factors like diameter, number, size and length of fruit with yield potential were highly genetic variations.

Coefficient of variation (CV): The results obtained from coefficient of variation (CV) which represents a useful statistic for comparing the degree of variation from one data series to another showed that all the parameters had low to high CV. Plant height had the lowest CV (2.1%) while the highest CV was recorded in percentage fruit damage per plant (25.7%).

Rank summation index (RSI): All the parameters were used in constructing a selection index for selecting insect pest tolerant and best performing garden egg cultivars. The rankings of the 5 garden egg cultivars (Table. 4) using agronomic and insect pest damage parameters showed that Ngwa large (V_5) is the best performer with a rank summation index (RSI) value of 17. This was followed by Sweet

white (V_3) with RSI values of 23. Cultivar Leafy eggplant (V_4) is the least of all the cultivars studied with the RSI value of 33.

Correlation: Selection based on the detailed knowledge of magnitude and direction of association between yield and its attributes is very important in identifying the key characters, which can be exploited for crop improvement through suitable breeding programme. Correlations between yield and yield components were computed separately for garden egg cultivars. The correlation studies of Pearson correlation coefficient (r) disclosed significant (p = 0.05) to highly significant (p = 0.01) level of probability among the traits studied (Table 3). Number of damaged fruits per plant was negatively correlated with Plant height (r = -0.50), fruit weight per plant (r = -0.30) and fruit yield per hectare (r = -0.30) and positively correlated with Percentage fruit damage per plant (r = 0.60) and percentage shoot damage per plot (r = 0.60). However, significant and positive correlation were found between fruit weight per plant and number of branches per plant (r = 0.40*) and number of fruit per plant (r = 1.00**). Similarly, Fruit yield was significantly and positively correlated with number of branches per plant (r = 0.40*), number of fruit per plant (r = 1.00**), Plant height (r = 0.60*) and fruit weight per plant (r = 1.00**) and recorded negatively and non- significant relationships with number of damage fruit per plant (r = -0.30), Percentage fruit damage per plant (r = -0.50) and percentage shoot damage per plot (r = -0.10). Darekar *et al*. (1991) got similar results in their studies. These results were also supported by Shukla et al. (1998).

Table 3: *Correlation matrix of some agronomic and damage parameters of 5 garden egg cultivars.*

Agronomic and Damage Traits	1	2	3	4	5	6	7
1.Number of branches per plant	-						
2.Number of fruit per plant	0.40	-					
3.Number of damage fruit per plant	0.50	0.30	-				
4.Percentage fruit damage per plant (%)	0.30	0.50*	0.60	-			
5.percentage shoot damage (%) per plot	0.80	-0.10	0.60	0.80	-		
6.Plant height (cm)	0.10	0.60	-0.50	0.30	0.30	-	
7.fruit weight per plant (kg)	0.40*	1.00**	-0.30	-0.50	-0.10	0.60	-
8.fruit yield per hectare (t/ha)	0.40*	1.00**	-0.30	-0.50	-0.10	0.60*	1.00**

* Correlation is significant at the 0.05 level (2-tailed),
** Correlation is significant at the 0.01 level (2-tailed).

4. Conclusion:

There exist significant variations in the different garden egg cultivars studied with respect to agronomic and pest damage traits. The cultivar Sweet white (V_3) had the best rating when yield fruit was accessed as a single attribute. However when all the agronomic and pest damage attributes were subjected to rank summation index analysis, Ngwa large (V_5) emerged as the best cultivar in terms of L. orbonalis tolerance and agronomic yields. Furthermore, correlation results showed significant and positive relationship between fruit yield and number of branches per plant, number of fruit per plant, Plant height and fruit weight per plant. Ngwa large (V_5) and Sweet white (V_3) therefore could be recommended for testing on farmer's field since they could be used to overcome the challenges faced by garden egg farmers in the zone.

Corresponding Author:
C. J. Harriman,
Department of Agronomy, Michael Okpara University of Agriculture, Umudike, Abia State.
E-mail: harrimanchidi@gmail.com

References:

1- Abdullah, A. A., Hegazi, H. H., & Almousa, I. A. (2003). Evaluation of Locally-grown Pumpkin Genotypes in the Central Region of Saudi Arabia. J. King Saud Univ, 15, 13-24.

2- Adeniji, O. T. (2003). *Inheritance studies in West African okra* (A. caillei). M. Agric (Doctoral dissertation, Thesis. the University of Agriculture. Abeokuta, Nigeria, 98p).

3- Casas, A., Caballero, J., Valiente-Banuet, A., Soriano, J. A., & Dávila, P. (1999). Morphological variation and the process of domestication of Stenocereus stellatus (Cactaceae) in Central Mexico. *American Journal of Botany,* 86(4), 522-533.

4- Aremu, C. O., Adebayo, M. A., Ariyo, O. J., & Adewale, B. B. (2007). Classification of genetic diversity and choice of parents for hybridization in cowpea Vigna unguiculata (L.) Walp for humid savanna ecology. *African journal of biotechnology,* 6(20).

5- Ariyo, O. J. (1993). Genetic diversity in West African okra (Abelmoschus caillei) (A. Chev.) Stevels—Multivariate analysis of morphological and agronomic characteristics. *Genetic Resources and Crop Evolution,* 40(1), 25-32.

6-Bajaj, K. L., Kaur, G. and Chadha, M. L. (1979). Glycoalkaloid content and other chemical constituents of the fruits of some eggplant (Solanum melongena L.) *varieties. Journal of Plant Foods*, 3(3): 163-168.

7- Roy, B. C., Rahim, K. M. B., & H. etc. Chatterjee. (2006*). Socio-economic parameters of pesticide use and assessment of the impact of an IPM strategy for the control of eggplant fruit and shoot borer in West Bengal,* India (No. 635.646 S678s). AVRDC.

8-Botwe, B. O., Ntow, W. J. Kelderman, P. Drechsel, P., Carboo, D. Nartey, V. K and Gijzen, H. J. (2011). Pesticide Residues Contamination of Vegetables and their Public Health implications in Ghana. *Journal of Environmental Issues and Agriculture in Developing Countries*, 10-18.

9- Bull, D. (1992). *A growing problem: pesticides and the Third World poor*. Oxfam..

10-Chakraborty, S. and Sarkar, P.K. (2011). Management of Leucinodes orbonalis Guenee on eggplant during the rainy season in India. *Journal of Plant Protection Research:* 325- 328.

11-Chanda, M.L. (1993). Improvement of brinjal. In: Chandha K. L. and Kallo G. (eds.) Advances in Horticulture: Vegetable Crops. *Malhotra Publishing House.* New Dehli, India. pp. 105-135.

12-Chen, N. C. and Li, H. M. (1996). Cultivation and breeding of eggplant. In: Training workshop on vegetable cultivation and seed production technology. *Asian Vegetable Research and Development Center*, Shanhua, Tainan. pp. 1-26.

13-Dadmal, S. M., S. B. Nemade and M. D. Akhare. (2004). Biochemical basis of resistance to Leucinodes orbonalis Guen. in brinjal. Pest *Management in Horticultural Ecosystems*. : 185-190.

14-Danquah, J. A. (2000). *Variation and Correlation among Agronomic Traits in Garden Egg (Solanum gilo Raddi)*. B.Sc. Dissertation. Department of Crop Science, College of Agriculture and Consumer sciences, University of Ghana Legon-Accra, Ghana.

15-Darekar, K. S., B. P. Gaikwad and U. D. Chavan. 1991. Screening eggplant cultivars for resistance to shoot and fruit borer. *J. Maharashtra Agril. Univ*. 16(3) 366-369.

16-Dutta, P., Singha, A.K., Das, P. and Kalita, S. (2011). Management of brinjal fruit and shoot borer, Leucinodes orbanalis Guenee in the agro-ecological condition of West Tripura. *Scholarly journal of Agricultural Science*: 16-19.

17-Gapud, V.P. and Canapi, B.L. (1994). A preliminary survey of insects of onions, eggplant and string beans in San Jose, Nueva Ecija. Philippines Country Report, IPM CRSP – First Annual, from http://www.oired.vt.edu/ipmcrsp/communications/annrepts/ nnrep94/Phil_country_rpt.html Retrieved on January 30, 2012).

18-Ghimire, S.N., Upreti, G., Thapa, R.B. and Manandhar, D.N. (2007). Eco-friendly management of brinjal fruit and shoot borer, Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae*). IAAS Research Advances* 2: 127-131.

19-Grubben, G. J. H. and Denton, O. A. (2004). *Plant Resources of Tropical Africa II: Vegetables.* PORTA Foundation, Wageningen, Nerthalands/ Backhuys Publishers, Leiden Netherlands. pp. 667.

20-Hanson, P.M., Yang, R.Y., Tsou, S.C.S., Ledesma, D., Engle, L. and Lee, T.C. (2006). The diversity of eggplant (Solanum melongena) for superoxide scavenging activity, total phenolics and ascorbic acid. *Journal of Food composition and Analysis* 19(6-7): 594-600. DOI: 10.1016/j.jfca.2006.03.001.

21-Harriman, J.C., Ngwuta, A. A., Onyishi, G. C., Nze, E. O., Janeth, O. O. And Ndulue, N. K. (2014). The genotypic performance of 15 maize cultivars for stem borer resistance in owerri west, south eastern Nigeria. *International Journal of Advanced Research*. , Issue 8, 800-815.

22- Horna, D., Smale, M., Al-Hassan, R., Falck-Zepeda, J., & Timpo, S. E. (2008). Insecticide use on vegetables in Ghana*: Would GM seed benefit farmers*? Intl Food Policy Res Inst.

23- Kale, P. B., Mohod, U. V., Dod, V. N., & Thakare, H. S. (1986). Screening of brinjal germplasm (Solanum spp.) for resistance to shoot and fruit borer (Leucinodes orbonalis Guen.) under field conditions. *Vegetable Science*, 13(2), 376-382.

24- Kennedy, J. S. (1965). Mechanisms of host plant selection. *Annals of Applied Biology*, 56(2), 317-322.

25-Malik, A.S., Dhankhar, B.S. and Sharma, N.K. (1986). Variability and correlation among certain characteristics in relation to shoot and fruit borer, (Leucinodes orbonalis Guen.) infestation in brinjal. *Hariyana Agriculture University Journal Research* 16(3): 259-265.

26-Martin, S. (2004). Biochemical and molecular profiling of diversity in Solanum spp. and its impact on pests. An MS thesis in Biotechnology, Tamil Nadu Agricultural University, *Coimbatore*, India. p. 124.

27-National Research Council (2006). Lost Crops of Africa. Volume II: Vegetables. The National Academies Press, Washington, D.C. http://www.nap.edu/catalog/11763.html. Accessed on 10th July 2013.

28-NEST. (1991*). Nigeria Environmental Study Action. Nigeria Threatened Environment: A National Profile*. Nigeria

29-Owusu-Ansah F., Afreh-Nuamah K., Obeng-Ofori D and Ofosu-Budu K.G. (2001). Managing

infestation levels of major insect pests of garden eggs (Solanum integrifolium L.) with aqueous neemseed extracts, *Journal of the Ghana Science Association,* 70-84.

30-Owusu-Ansah, F., Afreh-Nuamah, K., Obeng-Ofori, D. and Ofosu- Budu, K. G. (2001). Managing Infestation Levels of Major Insect Pests of Garden Eggs (Solanum integrifolium L.) with aqueous neem seed extracts. *Journal of the Ghana Science Association* 70 - 84.

31-Painter, R.H., (1951) *Resistance in crop plants. Macmillan,* New York, pp: 520.

32- Panda, N., & Khush, G. A. (1995). *Host plant resistance to insects. Cab International*.

33- Patnaik, H. P. (2000). Flower and fruit infestation by brinjal shoot and fruit borer. Leucinodes orbonalis Guen. Damage potential vs. weather. *Vegetable Science*, 27(1), 82-83.

34- Phoulivong, S. (2011). Colletotrichum, naming, control, resistance, biocontrol of weeds and current challenges. *Current Research in Environmental & Applied Mycology*, 1(1), 53-73.

35- Thomas, G. M., & Poinar, G. O. (1978). *Diagnostic Manual for the Identification of Insect Pathogens*. Plenum.

36- Rahman, M. A., Uddin, M. M., Haque, M. A., & Rahman, M. M. (2015). Varietal Preference of Okra Shoot and Fruit Borer, Earias vittella (Fab.) under Field Condition in Bangladesh. *Academic Research Journal of Agricultural Science and Research*, 3, 8-12.

37-Saimandir, J. and Gopal, M. (2012). Evaluation of synthetic and natural insecticides for the management of insect pest control of eggplant (Solanum melongena L.) and Pesticide Residue Dissipation Pattern. *American Journal of Plant Sciences*: 214-227.

38- Khorsheduzzaman, A. K. M., Alam, M. Z., Rahman, M. M., Mian, M. K., & Mian, M. I. H. (2010). Biochemical basis of resistance in eggplant (Solanum melongena L.) to Leucinodes orbonalis Guenee and their correlation with the shoot and fruit infestation. *Bangladesh Journal of Agricultural Research*, 35(1), 149-155.

39-Stone, A., Massey, A., Theobald, M., Styslinger, M., Kane, D., Kandy, D., Tung, A., Adekoya, A., 40-Madan, J. and Davert, E. (2011). Africa's Indigenous Crops-African eggplant: The fruit that's enjoyed as a vegetable In State of the World Innovations that Nourish the Planet, L. Mastny (Ed.). World Watch Institute. January 2011, pp. 21.

41-Than, P. P., Prihastuti, H., Phouliving, S., Taylor, P. W. J., and Hyde, K. D. (2008). Review: Chilli anthracnose caused by Colletotrichum species. *Journal of Zhejiang University Science* B, 9 (10): 764-778.

42-Thapa, R.B. (2010). Integrated management of brinjal fruit and shoot borer, Leucinodes orbonalis Guen: An overview. *Journal of Institute of Agriculture and Animal Science* 30 &32: 1- 16.

43-Thomas, B. and B. Vince-Pruce, (1997). *Photoperiodic in Plants*, 2 Ed, Academic Press, San Diego., pp: 4

44-Tindal, H. D. (1992). *Vegetables in the tropics. Macmillan Press Limited*, London and Basingstoke. pp. 533.

45-Voorrips, R. E., Finkers, R. and Sanjaya, L. (2004). QTL mapping of anthracnose (Colletotrichum spp.) resistance in a cross between Capsicum annuum and C. Chinese. *Theoretical and Applied Genetics*, 109: 1275–1282.

Received February 05, 2016; revised February 18, 2016; accepted March 01, 2016; published online April 01, 2016.

A Conceptual Model for Successful Leadership in Nursing Education in the United Arab Emirates

Briliya Rajabel Devadas

Senior Lecturer in Child Health Nursing, Fatima College of Health Sciences, Abu Dhabi, UAE
briliya.devadas@fchs.ac.ae

ABSTRACT

Purposes: The purpose of this paper is to reveal interview findings from an empirical study, conducted with a nursing education leader currently working in the UAE, to remedy the paucity of literature, related to leadership issues in nursing education in the country; and to synthesize all relevant literature review material into proposing a culturally suitable model for nursing education leadership in the UAE.

Design: A review of the literature on authentic transformative leadership was conducted and select successful leadership attributes have been discussed. A hermeneutic, phenomenological, semi-structured interview with a nursing leader in the field of nursing education currently working in the UAE was also conducted.

Findings: Emerging themes reflected global patterns such as the presence of a hierarchical leadership model, lack of communication, poor teaching resources and low student numbers. Successful attributes that can help cope with the challenges include-taking care of self, building the trust economy, perseverance, maintaining strong professional networks and cultivating relationships among faculty members. The Excellence in Nursing Education Model by the National League for Nursing has been adapted for the proposed conceptual model for successful nursing education in the UAE.

To cite this article
[Devadas, B. R. (2016). A Conceptual Model for Successful Leadership in Nursing Education in the United Arab Emirates. *The Journal of Middle East and North Africa Sciences*, 2(4), 39-46]. (P-ISSN 2412- 9763) - (e-ISSN 2412-8937). http://www.jomenas.org. **5**

Keywords: Nursing Leadership, Nursing Education, United Arab Emirates, Hermeneutic Phenomenological interview, Qualitative research, Conceptual Model

1. Introduction:

Nursing is ever changing, ever growing, striving to meet the myriad health care needs of the society to which it caters. Nursing education seeks to provide the theoretical background and technical skill competency required of nurses to meet these demands. Since the 1990s, various schools of nursing affiliated with universities or government agencies have for short periods offered the baccalaureate degree in nursing, with an example being the Institute of Nursing in Abu Dhabi, which was dissolved to give way for the nursing program in the Higher Colleges of Technology in 2004, which subsequently closed in 2009, and currently, the Fatima College of Health Sciences in Abu Dhabi (started in 2006) is offering the nursing degree to its students (Wollin and Fairweather 2012).This raises the question, why do some schools of nursing flourish while others flounder?

According to Horton-Deutsch et al. (2011), "academic nursing leaders, are one component of a well-prepared faculty, required to achieve and sustain excellent educational programs" (p. 222). Hence the purpose of this paper is: (i) to provide interview findings from an empirical study, conducted with a nursing education leader currently working in the UAE, to remedy the paucity of literature, related to leadership in nursing education in the country; and (ii) to synthesize all relevant literature review material in proposing a culturally suitable model for nursing education leadership in the UAE.

2. The Current Status of Leadership in Nursing Education – Globally, and in the United Arab Emirates:

Nursing education is never constant and throughout its history, nursing programs offered, have been a direct reflection of social, political, and

economic trends and issues. According to Feldman and Greenberg (2005:11), "nurses lead patients, families, groups, communities, committees, organizations" – all highly challenging and demanding, and, therefore, the need for effective nursing leadership is critical. Nurse educators have multifaceted influential dimensions where nursing leadership is enacted – either with students in the classroom or with faculty members at a meeting, on a local level within the organization or at a national even international platform (Horton-Deutsch 2010). In this section, issues common to higher education in the UAE, and pertinent to higher education in nursing, in the UAE, have been identified. A comparison has been made between nursing education in the UAE and some select other developing countries also, with a view at identifying common global concerns in the field of nursing education.

A look at challenges in nursing education leadership in other developing countries has identified several areas for change and significant improvements in the field, with the first and foremost being a global shortage in nurses' attrition and retention in the profession. The World Health Organization in its report, (2006) stressed that the critical workforce shortage is severe enough to start impacting on the delivery of global essential nursing care. The nursing profession in Singapore has yet to reach its required target of qualified nurses at the different levels. Arthur (2008) has succinctly described their current challenges as-creating new programs, developing a research agenda in an environment where there are only a few Ph.D. holders, resulting in minimal research output, managing faculty who are not familiar with the university system and altering the climate where diploma nurses are the norm.

Turale, Ito, Murakami and Nakao (2009) conducted a study to understand nursing scholarship in Japan, and concluded that Japanese scholars required, "improved English proficiency levels, national and international collaboration with other nurses, political and assertive skills to take control of nursing education and be more involved in research collaborations and international publications" (p. 166). Yet another study by Turale, Klunklin and Chontawan (2010) explored similar perspectives among nurse scholars in Thailand and revealed that visionary leadership, resource sharing among universities, and scholarships to study abroad were major indicators for growth, while high teaching loads, minimum research publications, lack of mentorship and lack of consensus related to entry nurse practices, were some barriers to scholarship.

Higher Education in the United Arab Emirates, since the nation's unification in1971, has progressed at a remarkable pace with technological innovations and globalization impacts creating rippling effects that have swept across the field and its importance is reflected in Article 17 of the UAE constitution which states that, "Education is a fundamental factor for the progress of the society" (2010:10). The majority of the workforce in the UAE currently is constituted by foreign labor and according to Mograby (1999), the imbalance is due to the relatively small size of the national population and the relentless rigorous pace of its economic development. A decade later, Kirk (2010) observes as a "demographic anomaly" that Emiratis are still outnumbered, twice – once in the general population and again in the workforce. This has led to the formulation of a national campaign with an aim to educate and recruit more Emiratis into the machinations of the state and resulted in a strain on the national education system.

With a need for restructuring and remodeling its educational systems, simultaneous to the need for graduating workplace ready employees, Kirk (2010) explains that- the UAE has responded to the situation by the "quick-fix" solution of buying the educational models and expertise it requires, which were mostly western models, as opposed to the comparatively slow but steady process of building its own indigenous education system. He identifies several implementation constraints as a result of the employed strategy, first and foremost being, poor English proficiency levels among the local population. This required considerable effort, before the skill development and technical know-how, along with relevant information and communication technology strategies were incorporated as part of the curriculum. There was also a felt need for capacity building of leaders in every field, in line with the vision of the Ministry of Education, to promote enduring, sustainable development in the community. In the field of education, there are very few Emiratis in leadership positions and this lack of local talent has resulted in the migration of teaching personnel, mostly from the surrounding Arab countries, who lack the culturally relevant identity required in their position.

The Ministry of Higher Education and Scientific Research was established in 1992 to deal with the higher education sector. Its role is to regulate and accredit all higher education institutions and programs, both private and public. Currently, education in the UAE is being re-evaluated and re-examined to improve its adaptability and accurately reflect changing trends in the global arena and this has been formalized by the policy to recruit 90% of the teachers in the national schools from the local population by 2020 (Kirk 2010). The Emirates Center for Strategic Studies and Research (ECSSR), in a

featured article on its website, calls the UAE leadership model, "a model of Constructive Engagement with the Nation" (Al Awadhi 2012), based on the premise that, "if the leadership is more interactive and responsive to the people, it will be capable of achieving its goal." This has been accomplished partly by the generous national funding and support from the Nation's leaders which has contributed to the sense of security in its citizens.

Nursing education, which falls under the umbrella of higher education in the UAE, needs to fulfill one key strategy among the list of the UAE Government Strategies (2011-2013) and ensure world-class health care to its citizens and residents. Effective nurse leaders are the need of the hour to ensure quality nursing education and equip its largest section of health care providers to rise to the challenge, and provide optimal care to the society. In the UAE, as with other higher education programs, there is an import of foreign curricula in the field of nursing education, an example being, the North American system which was used in the Higher colleges of Technology, from 2004 – 2009 and the Australian Griffith University curricula currently being used in the Fatima college of Health Sciences (Wollin and Fairweather 2012). Similar to other institutions in the UAE, a lack of local talent has led to the import of skilled workforce, especially expert academics, mostly western and the other Arab regions but also some from Asia, to assess, deliver and evaluate the nursing curriculum for the students.

There is a growing number of women in the higher education system in the UAE, in recent years, but an overdependence on expatriate nurses, coupled with common misunderstandings regarding the role of a nurse, lingering perceptions of nurses being the handmaiden of doctors, low educational levels and limited knowledge regarding scope of practice of nurses, have resulted in only 3% of the local population taking up the profession as a career choice (Wollin and Fairweather 2012). Another concern, identified by Wollin and Fairweather (2012) in the UAE, is the continued education of practicing nurses at the diploma level, which have resulted in a shortage of bachelor-qualified nurses in the country. In recent years, Wollin and Fairweather (2012) note that providing locally educated, bachelor degree nurses, fluent in Arabic, have been recognized as a sustainable alternative and hence the development of bachelor programs in nursing in the UAE.

Bass (1999:12) suggests that "resolution of this issue may lie in the alignment of personal principles with those of the group, organization, and society" and believed that there is a current need for leaders to be more transformational if they sought to maintain effectiveness. He describes transformational leadership to, "the leader moving the follower beyond immediate self-interests through idealized influence, inspiration, intellectual stimulation or individualized consideration" (p. 11). Burns (1978, cited in Bass and Steidlmeier 1998) discusses transformational leadership as involving moral uplifting of followers, but Bass and Steidlmeier (1999) argue that the absence or presence of a moral foundation in the leader himself is what forms the distinction between authentic versus pseudo-transformational leadership. Norris et al. (2002) describe transformational leadership as a "shifting of influence that allows many followers to emerge as leaders at particular points in time". Bush (2003) agrees that transformational leadership is currently in vogue, but cautions that it may become a tool to rob followers of their individual vision.

Avolio and Gardner (2005), therefore, with an aim to refocus on what constitutes genuine leadership, developed authentic leadership to form a generic root construct for other forms of positive leadership like transformational leadership and the advent of their work on authentic leadership, has sprung from Bass and Steidlmeier (1999) earlier mentioned argument that there are pseudo versus authentic transformational leaders. Their central premise is that "through self-awareness, self-regulation, and positive modeling, authentic leaders foster the development of authenticity in their followers" (p. 317), and ethicality is a central component of this leadership practice.

3. Interview with a Nursing Education Leader in the UAE:

Nursing education in Abu Dhabi began in 1974, with the establishment of the first school of Nursing, but till date, no studies have been published in the extensively reviewed literature on the nature of nursing education leadership in the UAE. This section consists of the results of a hermeneutic phenomenological interview, conducted with a leader in the field of nursing education, currently working in the UAE, regarding nursing leadership in the UAE, to remedy the paucity of literature in this area and to collect some empirical data on the challenges faced by nursing education leaders in the region, with a view at discussing the findings later, in relation to the rest of the literature. This interview has been beneficial in shedding some much-needed light on some of the challenges faced by nurse leaders in establishing nursing programs in the UAE in particular, and the leadership qualities required to successfully resolve these issues.

The study has been conducted, with the purpose of identifying some of the challenges faced by nurse leaders, in establishing nursing programs in the UAE and to gain some insight on leadership

qualities, particularly interpersonal attributes that could help successfully combat these challenges. The purpose aligns itself with the philosophies, strategies, and intensions of the interpretive research paradigm which seeks to understand a human phenomenon and the related experiences underlying it (Ajjawi and Higgs, 2007). The objectives of the study were- to illicit the experience of being a nurse education leader in the UAE; to identify some of the challenges faced by nursing education leaders, from an UAE perspective; and to ascertain select interpersonal attributes of leadership that can help built resilience in coping with these challenges, especially in the UAE context.

4. Research Approach and Methodology:

Gadamer's hermeneutic phenomenology provided the philosophical framework for the study as it is a primary and universal way of our being in the world (Polit and Beck 2006). As the requisite in a hermeneutic phenomenological study is to collect rich and dense information concerning the phenomena, purposive sampling was used to locate the participants (Polit and Beck 2006). Frank (2005) defines an expert as one having "profound knowledge and is competent in using this knowledge". A nursing expert is someone who does not let principles and rules guide her action, who has a rich background experience and is highly proficient in performance. Thus, an experienced nurse currently holding a leadership position in the field of nursing education in the UAE was recruited for the study. Ethical approval for the interview was obtained, and a participant information sheet was given to the participant, detailing the interview's goal of collecting empirical evidence towards the practice of nursing education leadership; within the UAE context. Participant rights and confidentiality of data were explained and individual consent was obtained.

In hermeneutic phenomenology, the interview is a commonly used data collection strategy as it serves a very specific purpose. According to Patton (2002, cited in Glesne 2006), "kinds of questions include experience/ behavior questions, opinion/value questions, feeling questions, knowledge questions, sensory questions, and background / demographic questions". A tape recorded, thematically structured, narrative, open-ended interview was conducted with a nurse leader in the field of nursing education, with experience working in the sphere of nursing education in UAE, based on principles of qualitative interviewing, Glesne (2011), and Kvale and Brinkmann (2009).

Specific research questions included: (i) How would the interviewee describe her experience of being a nurse leader, in an institute of nursing education, in the UAE? (ii) What, in her opinion, would be some of the challenges faced by nursing leaders in the field of nursing education, from an UAE perspective? And (iii) what interpersonal attributes of leadership that can help built resilience in coping with these challenge especially in the UAE context? Results of the interview have provided rich empirical data, which along with previously reviewed literature will help towards the formulation of a conceptual model of successful nursing leadership in the field of nursing education in the UAE context. (See Appendix B)

3.2. Results and Discussion:

Findings from the interview were categorized into "challenges in nursing education in the UAE" and "successful attributes for coping, within the UAE perspective". Under the first category, the interviewee shared that the hierarchical leadership model is still currently operating in nursing education in the UAE with terms like, "old school thinking", "one-man show" and "prehistoric model" used to describe the situation (personal communication 2012). This is similar to Dada's (2011: 203) view, "that the hierarchy present in educational organizations was one likely suspect in the implementation of the program and its ability to sustain over time in the UAE". In her view, constraints included – lack of clarity and communication within the system, poor teaching resources and no voice for the nursing academic at the top managerial level. Successful attributes that can help cope with the challenges include-taking care of self, building the trust economy, perseverance, maintaining strong professional networks and cultivating relationships among faculty members. The interviewee stressed that there was a need for collaborative leadership with shared responsibility and open attitude in nursing institutions in the UAE and a need for acceptance of advice from experts regarding diverse perspectives on a variety of issues (personal communication 2012).

Under "successful attributes for coping", the interviewee discussed that a nursing leader in the UAE context needed to have good personal support first, to be a good support/ advocate for others. In her opinion, this is done through seeking advice, taking care of one's health and maintaining strong professional networks within the profession. Perseverance, ability to influence people, ability to develop trust, make convincing arguments and having clarity in articulation were some of the qualities stressed by the interviewee as essential for successful leadership in the region, as is also, familiarizing oneself with the local culture. She quotes, "people are important and when relationships are cultivated one by one, it will slowly but surely result in the tipping point one day" (personal communication 2012). Some

of the issues identified as a result of the interview are similar to literature previously reviewed on issues facing nursing programs in nursing schools. It is interesting to note that the interviewee also highlighted the need to cultivate the authentic transformational dimension of individual consideration and inspiration, among the members of the institution.

4. A Conceptual Model for Successful Leadership in Nursing Education in the UAE:

This section of the paper syntheses all relevant material including current models in nursing education and leadership, with an aim at proposing a working conceptual model for successful nursing education leadership in the UAE, culturally sensitive to the UAE higher education system and reflective of the nursing profession. The National League for nursing (2006) recognized the importance of nursing education for the future development of internationally qualified clinicians, educators, researchers, and administrators, and developed a model of excellence in nursing education to prepare nurses with very high caliber. The model consists of eight core elements with components and subcomponents that are required for achieving and sustaining this excellence in nursing education. They are as follows:

1) Clear Programme Standards and Hallmarks that raise Expectations
2) Qualified students
3) Well prepared Educational Administrators
4) Evidence-Based Programs and Teaching/ Evaluation Methods
5) Quality and Adequate Resources
6) Student-centered, Interactive, Innovative Programs, and curricula
7) Recognition of experts, and
8) Well-prepared faculty

In response to nursing education in the UAE, the "idealized influence" component of authentic transformational leadership can lead to the creation of a suitable organizational culture, strive for perseverance till the goal is achieved (personal communication, 2012) and provide a vision for proactive adaptive change (Huston 2008). Inspirational motivation can influence mentoring and networking within the organization, recognition, and reward for the followers (Bass and Stedlmeier, 1999), and build on the currency of trust (personal communication, 2012). When the authentic transformational leader pays individual consideration to the followers in the organization, the result is open channels of communication, acceptance of advice from experts and open attitude (personal communication 2012). And, finally, intellectual stimulation brings about empowered followers who share responsibility for innovation and rise to meet the multifaceted challenges facing nursing education in the country.

Authentic transformation of nursing leadership in the field of education in the UAE, will ultimately lead to excellence in nursing education in the UAE, by achieving the subcomponents of a well- prepared faculty, leading to accomplishment of a student-centered, innovative, customized curriculum; mentoring of new faculty; implementation of evidence-based teaching including best practice guidelines; recruiting, retaining and graduating qualified students; advancing the profession and building an accredited nursing program leading to recognition within the UAE community; laying the ground fertile for international research collaborations and promoting a culturally suitable authentic organizational culture, as envisioned by the Nursing League for nursing (2006), as shown in Figure 1

5. Conclusion:

This paper has attempted to respond to the issues concerning nursing education, and the challenges faced by leaders in nursing education from a UAE perspective, by proposing a conceptual model for successful leadership in nursing education in the UAE. Emerging themes from the interview reflected global patterns and included- presence of hierarchical leadership model, lack of communication, poor teaching resources and low student numbers. Successful attributes that can help cope with the challenges include-taking care of self, building the trust economy, perseverance, maintaining strong professional networks and cultivating relationships among faculty members. The Excellence in Nursing Education Model by the National League for Nursing has been adapted for the proposed conceptual model for successful nursing education in the UAE. The model proposes that an authentic transformational leader in nursing education can enhance the preparedness of the nursing faculty with far reaching influences over and across all other components, leading to the implementation of a successful sustainable nursing program, providing quality nursing care according to international standards, for the United Arab Emirates.

Corresponding Author:
Briliya Rajabel Devadas, Ph.D.
Senior Lecturer in Child Health Nursing, Fatima College of Health Sciences, Abu Dhabi, UAE
E-mail: briliya.devadas@fchs.ac.ae

References

1- Ajjawi, R., & Higgs, J. (2007). Using Hermeneutic Phenomenology to Investigate How Experienced Practitioners Lear n to Communicate Clinical Reasoning. *The qualitative report*, 12(4), 612-638.

2-Al-Awadi, A. 2012. The UAE leadership: a model of constructive engagement with the nation. The Emirates Center for Strategic Studies and Research [online] 17 January. [Accessed 13 March 2012]. Available at: http://www.ecssr.ac.ae/ECSSR/print/ft.jsp?lang=en&ftId=/FeatureTopic/Abdullah_AlAwadhi/FeatureTopic_1496.xml

3-Arthur, D. 2008. Singapore nursing: poised for growth and leadership in the region. *Nursing and Health Sciences* 10:167-168

4-Avolio, B. and Gardner, W. 2005. Authentic leadership development: getting to the root of positive forms of leadership. *The Leadership Quarterly* 16: 315-338

5-Bass, B. M. 1999. Two decades of research and development in transformational leadership. *European Journal of Work and Organizational Psychology* 8(1): 9-32

6- Bass, B. M., & Steidlmeier, P. (1999). Ethics, character, and authentic transformational leadership behavior. *The leadership quarterly*, 10(2), 181-217.

7- Bush, T. (2003*). Theories of educational leadership and management*. Sage.

8-Dada, R. 2011. 'Teacher leadership in the Arab Gulf: expatriates and Arab educators mentor each other', in C. Gitsaki (Eds). Teaching and Learning in the Arab World. Bern: Peter Lang AG, *International Academic Publishers* 203-228

9-El-Haddad, M. 2006. Nursing in the United Arab Emirates: a historical background. *Nurse Educator* 53:284-289

10- Feldman, H. R. (2005). *Educating nurses for leadership*. Springer Publishing Company.

11- Feldman, H. R. (2005). *Educating nurses for leadership*. Springer Publishing Company.

12- Glesne, C., & Peshkin, A. (2006*). Becoming qualitative researchers: An introduction* (p. 6). White Plains, NY: Longman.

13-Horton-Deutsch, S., Young, P. and Nelson, K. 2010. Becoming a nurse faculty leader: facing challenges through reflecting, persevering and relating in new ways. *Journal of nursing management* 18: 487-493

14-Horton-Deutsch, S., Pearsall, C., Stiles, K. and Young, P. (2011). Becoming a nursing faculty leader. *Nursing Education Perspectives* 32(4): 222-231

15-Huston, C. 2008. Preparing nurse leaders for 2020. *Journal of Nursing Management* 16: 905-911

16-Kirk, D. 2010. The development of higher education in the United Arab Emirates. *The Emirates Occasional Papers* 74: 1-57

17-Kronfol, N., and Athique, M. 1986. Nursing education in the United Arab Emirates. *International Journal of Nursing Studies* 23(1):1-10

18- Mograby, A. (1999). Human development in the United Arab Emirates: Indicators and challenges. *Emirates Center for Strategic Studies and Research* (Ed.).

19-National League for Nursing. 2006. *Excellence in nursing education model*. New York: Author

20- Norris, C. J., Barnett, B. G., Basom, M. R., & Yerkes, D. M. (2002). *Developing Educational Leaders. A Working Model: The Learning Community in Action*. Teachers College Press, PO Box 20, Willliston, VT 05495-0020 (paperback: ISBN-0-8077-4183-3, $22.95; cloth: ISBN-0-8077-4184-1, $47).

21- Polit-O'Hara, D., & Beck, C. T. (2006*). Essentials of nursing research*: Methods, appraisal, and utilization (Vol. 1). Lippincott Williams & Wilkins.

22- Turale, S., Ito, M., Murakami, K., & Nakao, F. (2009). Nursing scholarship in Japan: Development, facilitators, and barriers. *Nursing & health sciences,* 11(2), 166-173.

23- Turale, S., Klunklin, A., & Chontawan, R. (2010). Growing together: a qualitative study of leading nurse scholars in Thailand. *International nursing review,* 57(2), 202-210.

24-UAE Government Strategy. 2011-2013.Putting citizens first, an accountable, lean, innovative, and forward-looking government. [Online]. [Accessed 13 March 2012]. Available at: http://www.uaecabinet.ae/English/Documents/PMO%20StrategyDocEngFinV2.pdf

25-United Arab Emirates Constitution. 1971. [Online]. [Accessed 13 March 2012]. Available at: www.worldstatesmen.org/uae_const.doc

26-Wollin, J and Fairweather, C. 2012. Nursing education: a case study of a Bachelor of Science Nursing program in Abu Dhabi, United Arab Emirates. *Journal of Nursing Management* 20: 20-27

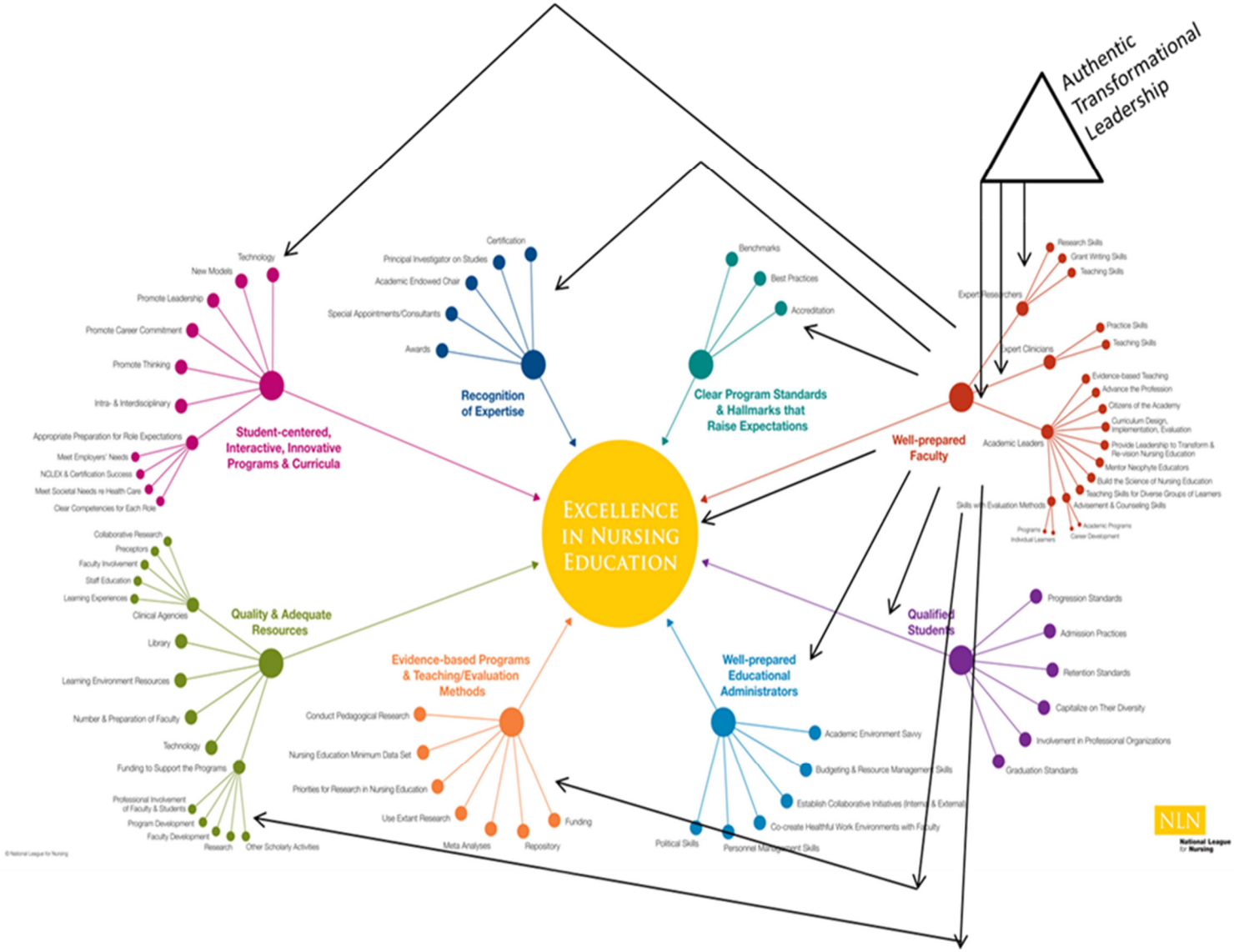
27-World Health Organization. 2006. Working together for health [online]. [Accessed 13 March 2012]. Available at: http://www.who.int/whr/2006/whr06_en.pdf

Received February 07, 2016; revised February 19, 2016; accepted March 01, 2016; published online April 01, 2016.

Appendices

Appendix A

Figure 1. Proposed Conceptual Model for Successful Leadership in Nursing Education in the UAE



Appendix B

Draft Interview Guide

Name of the Study: A Conceptual Model for Successful Leadership in Nursing Education in the UAE

Interview guide:

- How would you describe your experience of being a nurse leader, in an institute of nursing education, in the UAE?
- Could you provide some examples to illustrate your statement?
- What, in your opinion, would be some of the challenges faced by nursing leaders in the field of nursing education, from the UAE perspective?
- I am interested in the interpersonal attributes of leadership that can help built resilience in coping with these challenges, especially in the UAE context. Could you shed some light on essential leadership qualities from that perspective?
- Is there anything else that you would like to comment or add upon?

Thank you,

Serum Calcium and Phosphorus Levels during Different Stages of Pregnancy

Nagah A.A. Mohammed[1]* • Mohammed Amanullah[2]
Faroug Bakheit Mohamed Ahmed[3] • Anga Elsafi[4]

[1]Associate Professor, Department of Medical Biochemistry, Faculty of Medicine, Ondokuz Mayis University, Samsun-Turkey
[2]Associate Professor, Department of Clinical Biochemistry, College of Medicine, King Khalid University, Abha, Saudi Arabia
[3]Associate Professor, Department of Biochemistry, Faculty of science and technology, Shendi University, Shendi, Sudan.
[4]M.Sc. student, Clinical chemistry, Faculty of Medical Laboratory Sciences, Sudan University of Science and Technology, Sudan.
amanullahmohammed@yahoo.com

Abstract: The aim of this study was to compare serum calcium and phosphate levels between pregnant women in different stages of pregnancy and healthy non-pregnant women aged 32 ± 3 yrs. This study discerned a significant reduction (P values 0.03, 0.04) in the serum calcium level in first (7.7 ± 0.34, 10.2 ± 0.43) second trimester (8.0 ± 0.39, 10.2 ± 0.43) whilst insignificant levels were found in third trimester between pregnant women and control group at P value 0.06 (9.7 ± 0.27, 10.2 ±0.43). Phosphorus levels were insignificant between different stages of pregnancy and between study and control group (P value 0.33, 0.31, 0.31) with mean ± SD for the first (3.16 ±0.36, 3.16 ±0.36), second (3.17 ±0.31, 3.16 ±0.36) and third (3.16 ±0.31, 3.16 ±0.36) trimester. Correlation showed weak negative correlation between calcium level in first and second trimester and very weak correlation in third trimester of pregnancy (R = -0.47, -0.58 and -0.22) and no correlation detected between phosphorus level and all stages of pregnancy (R = 0.00, 0.00, 0.00). This study concluded that pregnancy is associated with significant reduction in serum calcium level during the first and second trimester of pregnancy. Calcium level also correlates weakly negative with the duration of pregnancy. Phosphorus level does not affect either by circumstances of pregnancy nor its different stages. Human body resemble to demineralization bone calcium in order to attain normal calcium hemostasis.

To cite this article
[Mohammed, N. A. A., Amanullah, M., Ahmed, F. B. M., & Elsafi, A. (2016). Serum Calcium and Phosphorus Levels during Different Stages of Pregnancy. *The Journal of Middle East and North Africa Sciences*, 2(4), 47-49].
(P-ISSN 2412- 9763) - (e-ISSN 2412-8937). http://www.jomenas.org. **6**

Keywords: Pregnancy, Calcium, Phosphorus, Osteomalacia, and Cholestasis.

1. Introduction:

Calcium and inorganic phosphate are macronutrients and are very essential for bone formation in fetus (Mayne, 1996). In pregnancy, the very high concentration of circulating estrogen and progesterone alter the concentration of many substances in the maternal blood (Khastigir & Studd, 1994). A direct linear relationship has been established between daily dietary intake of calcium and serum calcium concentration. The menstrual cycle is associated with hormonal and physiological changes in the female body (Easthan, 1985).

Fetus skeleton is formed during pregnancy period and bone mineralization highly demands minerals, supplied maternally. Bone is greatest reservoir for calcium. Significant changes may occur in maternal skeletal system during the pregnancy that may result in osteoporosis and Osteomalacia (Prentic, 1994). Although major part of calcium is absorbed by the fetus in third trimester of pregnancy, however, calcium homeostasis begins from the earliest time of pregnancy.

Most studies of calcium metabolism in pregnancy have examined changes in serum markers of bone formation and urine markers of bone resorption, these studies fraught with a number of confounding variables, including lack of pregnancy baseline values, hemodilutional effect on serum markers, increase glomerular filtration rate and renal clearance changing in renal excretion. Many studies have reported that urinary markers of bone resorption (24h urine) are increased from early to mid-pregnancy conversely serum markers of bone formation are often decreased from early to mid-pregnancy and then rising to normal value. It`s conceivable that the bone formation marker are artificially lowered by normal hemodilution and increased renal clearance during pregnancy (More, Bhattoa, Bettembuk, & Balogh, 2003). There are limited studies on the effects of pregnancy on bone turn-over marker in human; however the existing evidence suggests that the turn-over is low in the first half and increased towards the end of pregnancy (Kovacs & Kronenberg, 1997).

At the gestational age, diet may influence the bone metabolism during pregnancy and demonstrated controversial data. The most adaptive change in the third trimester is the protection of the maternal skeleton from bone density loss which is due to the shift in levels of 1, 25-dihydroxy vitamin D (Oliveri, Parisi, Zeni, & Mautalen, 2004). Plasma calcium and phosphorus are mainly regulated by parathyroid hormone and the active form of vitamin D and any interference with the action of vitamin D and Parathyroid hormone is reflected on the plasma concentration of calcium and phosphorus (Varley, 2000). In summary, the extra demand for calcium from the growing fetus, especially during the third trimester is physiologically compensated through changes in hormonal levels leading to increased intestinal absorption, decrease renal execration and intestinal calcium absorption becoming the primary source of calcium (Kovacs, 2001).

To the best of our knowledge, there is lack of information regarding assessment of serum calcium and phosphorus during different stages of pregnancy, factors that might affect both health of mother and fetus. So this study aims to measure serum calcium and phosphorus levels in healthy Sudanese pregnant women and compared to non-pregnant women. In addition to correlate serum calcium and phosphorus levels with the duration of pregnancy.

2. Material and Methods:

This case-control study was performed in Khartoum state during period from June to September 2015. One hundred and fifty blood samples were collected from healthy Sudanese pregnant women and were divided equally into first, second and third trimester as test group and fifty samples were obtained from healthy non-pregnant women as control group for the comparison, both groups were age matched (32 ± 3) yrs. Women with cholestasis, bone disease, renal impairment, and those who were under nourished with calcium or pregnant nursing were excluded from this study.

3. Ethical consideration:

Permission of this study was obtained from the manager of laboratory in Om Durman specialized maternal hospital. The objectives of the study were explained to all individual participating in the study. Health education about pregnancy was provided to all participants.

4. Sampling:

After informed consent and use of alcohol anti septic (70% ethanol) 3 ml of venous blood was collected using disposable syringe. The blood was collected in lithium heparin container and separated by centrifuge for 3 minutes, 3000/rpm. Serum calcium and phosphate were estimated by A 25 analyzer it`s fully automation.

5. Statistical analysis:

The data was analyzed using Statistical Package for Social Sciences (SPSS), Windows version 16, 1997 SPSS, Inc, Chicago, IL, and USA. Analysis of variance (ANOVA) and correlation were calculated.

6. Results:

This study discerned a significant reduction (P values 0.03, 0.04) in the serum calcium level in first (7.7 ±0.34, 10.2 ±0.43) second trimester (8.0± 0.39, 10.2± 0.43) whilst it was insignificant in third trimester between in pregnant women and control group at P value 0.06 (9.7 ± 0.27, 10.2 ±0.43).

Phosphorus level were insignificant between different stages of pregnancy and between case and control group of this study (P values 0.33, 0.31, 0.31) with mean ± SD for the first (3.16 ±0.36, 3.16 ±0.36), second (3.17 ±0.31, 3.16 ±0.36) and third (3.16 ±0.31, 3.16 ±0.36) trimester (Tables1 and 2)

Further this study showed a weak negative correlation between calcium level in first and second trimester and very weak correlation in third trimester of pregnancy (R = -0.47, -0.58 and -0.22) and no correlation was detected between phosphorus level and all stages of pregnancy (R = 0.00, 0.00,0.00) (Table 3).

Table 1: *Calcium level and pregnancy stages.*

Calcium level	First Trimester	Second trimester	Third trimester	Control
mean ± SD (mg/dl)	7.7 ±0.34	8.0 ±0.39	9.7 ± 0.27	10.2± 0.43
P .value	0.03	0.04	0.06	-

Table 2: *Phosphorus level during pregnancy stages.*

Phosphorus level	First trimester	Second trimester	Third trimester	Control
mean ± SD (mg/dl)	3.16± 0.36	3.17± 0.31	3.16± 0.31	3.16± 0.36
P value	0.33	0.31	0.31	-

Table 3: *The correlation between calcium and phosphorus levels and pregnancy stages.*

Parameter	First trimester	Second trimester	Third trimester
Calcium	- 0.47	- 0.58	- 0.22
Phosphorus	0.00	0.00	0.00

7. Discussion:

Serum calcium and phosphorus levels may vary depending on the physiological, biochemical and pathological variations (Mayne, 1996). In pregnancy, calcium and inorganic phosphate are important elements found in human body fluid in addition to sodium, potassium, magnesium and chloride. Serum calcium and phosphorus concentration might decrease during pregnancy due to insufficient dietary intake and that is directly proportional to the gestational age. In the present study, serum calcium was found to be significantly reduced in first and second trimester and insignificantly reduced in third trimester in pregnant women when compared to the control and there is a weak negative correlation with the duration of pregnancy. Serum phosphorus levels showed no significant difference in pregnant women when compared to the controls. That means the level of phosphorus concentration is not affected by pregnancy. Similar previous studies reported that there is no change in plasma phosphorus concentration during pregnancy.

Small significant increase observed in the serum calcium level in the third pregnancy, and phosphorus level is the same for all pregnancy stages (Power et al., 1999). Some decrease in the first and increase in third trimester in bone turnover and of pregnancy, also the turnover increase during lactation (Seely, Brown, DeMaggio, Weldon, & Graves, 1997).

The baby gets its vitamins and nutrients from its mother, especially during the third trimester. The significant decrease in serum calcium showed in this study could be attributed to demand of baby from his mother who feeds him minerals through maternal circulation.

If the pregnant mother does not take in enough calcium through the diet which she consumes, then she can get health problems and increase the risk of poor bone health. Thus, we recommend from this study measurement of serum calcium should be done regularly during pregnancy and pregnant women should take diet rich in calcium or calcium supplement if needed to compensate increase demand of fetus.

8. Conclusion and recommendations:

Serum calcium is significantly reduced during pregnancy but phosphorus level is not affected by pregnancy stages. Measurement of serum calcium should be done regularly during pregnancy and pregnant women should take diet rich in calcium or calcium supplement if needed to compensate increase demand of fetus.

Corresponding Author:
Mohammed Amanullah, Assoc. Prof.
Associate Professor, Department of Clinical Biochemistry, College of Medicine, King Khalid University, Abha, Saudi Arabia.
E-mail: amanullahmohammed@yahoo.com

References

1. Mayne, P. (1996). *Calcium phosphate and magnesium metabolism in Clinical chemistry in Diagnosis and treatment ELSB*.
2. Khastigir G., Studd J. (1994). Pregnancy-associated osteoporosis. *Br. J. Obst. Gynaecol*; 101,836 – 838.
3. Easthan R. D. (1985). *Calcium in biochemical values in clinic medicine*. 7th ed. John wright Sons; Bristol. pp 66 – 70.
4. Prentic A. A. (1994). Maternal requirement of during pregnancy and lactation. *The American Journal of Clinical Nutrition* 90(3):4775-48835.
5. More, C., Bhattoa, H. P., Bettembuk, P., & Balogh, A. (2003). The effects of pregnancy and lactation on hormonal status and biochemical markers of bone turnover. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 106(2), 209-213.
6. Kovacs, C. S., & Kronenberg, H. M. (1997). Maternal-fetal calcium and bone metabolism during pregnancy, puerperium, and lactation. *Endocrine reviews*, 18(6), 832-872.
7. Oliveri, B., Parisi, M. S., Zeni, S., & Mautalen, C. (2004). Mineral and bone mass changes during pregnancy and lactation. *Nutrition*, 20(2), 235-240.
8. Varley L. (2000). Practical clinical biochemistry 5th Ed, 850-882.
9. Kovacs C. S. (2001). Calcium bone metabolism in pregnancy and lactation, *The Journal article Clinical Endocrinology and metabolism* 86(3):2344-2348.
10. Power, M. L., Heaney, R. P., Kalkwarf, H. J., Pitkin, R. M., Repke, J. T., Tsang, R. C., & Schulkin, J. (1999). The role of calcium in health and disease. *American journal of obstetrics and gynecology*, 181(6), 1560-1569.
11. Seely, E. W., Brown, E. M., DeMaggio, D. M., Weldon, D. K., & Graves, S. W. (1997). A prospective study of calciotropic hormones in pregnancy and post-partum: reciprocal changes in serum intact parathyroid hormone and 1, 25-dihydroxyvitamin D. *American journal of obstetrics and gynecology*, 176(1), 214-217.

Received February 16, 2016; revised February 23, 2016; accepted March 01, 2016; published online April 01, 2016.

Levels of Stress and Coping Strategies Used by Nursing Students in Asian Countries: An Integrated Literature Review

Ahtisham Younas

Memorial University of Newfoundland and Labrador, St John's, Canada
ay6133@mun.ca, & ahtishamyounas66@gmail.com

ABSTRACT

Introduction: High-stress levels can directly or indirectly impede academic learning, performance, and health of the nursing students. There is ample literature reporting levels of stress and coping strategies used by the nursing students from within western world. However, this may not be applicable to Asian context. Therefore, there is a need to synthesize evidence regarding stress and coping of nursing students from Asia.

Purpose: The purpose of this paper was to critically review and appraise existing studies and identify data gaps regarding stress and coping strategies among nursing students in the Asian context.

Methods: Literature search was performed using keywords and different combinations of keywords such as "level of stress, stressors, coping strategies, nursing students, interns, undergraduate nurses" from PubMed, EMBASE, Cochrane, CINHAL, ASSIA, PsycInfo, Science Direct, and Google Scholar and other sources such as research gate, websites, reference lists, and Higher Education Commission of Pakistan's Electronic Library. The search limit was focused on Asian countries and limited studies were found in this area. The review included nine studies published between 2007 and 2014 from India, Pakistan, Iran, Philippines, Hong Kong, and Jordan.

Results: The critical appraisal of the studies was done in terms of study population, purpose, methodology, and ethical considerations. The key findings of the studies were described under four themes; levels of stress, common stressors, coping strategies, and association among stress, coping, and the demographic variables. Most of the studies reported that the nursing students experience moderate stress levels. In terms of coping, students used more positive coping strategies than negative strategies.

Conclusion: This review underlined the strength and limitations of the studies identifying the levels of stress and coping strategies of nursing students in Asian context. A number of methodological limitations were found in these studies indicating that this topic has not been adequately investigated. Therefore, further research is needed to expand the literature in this area.

To cite this article
[Younas, A. (2016). Levels of Stress and Coping Strategies Used by Nursing Students in Asian Countries: An Integrated Literature Review. *The Journal of Middle East and North Africa Sciences*, 2(4), 50-57].
(P-ISSN 2412- 9763) - (e-ISSN 2412-8937). http://www.jomenas.org. 7

Keywords: Levels of stress, coping strategies, nursing students, Asian countries, nursing education, nursing practice

1. Introduction:

Stress is defined as a pattern of negative physiological states and psychological responses. It occurs in situations where individuals perceive threats to their well-being, which they may be unable to meet (Lazarus & Folkman, 1984). Stress affects individuals in different ways and is considered a cause of physical, emotional, and psychological ill health (Ortqvist & Wincent, 2008). Continuous stress may trigger both negative and positive responses. These responses depend upon the coping abilities of individuals (Schneiderman, Ironson, & Siegel, 2005). Coping refers to the dynamic cognitive and behavioral efforts to handle both external and internal stressors (Lazarus & Folkman, 1984). It has been recognized as a stabilizing factor that may assist individuals in psychosocial adaptation during stressful events (Walton, 2002). The use of effective coping strategies enables the return to a stable state thereby reducing the negative effects of stress (Sheu, Lin, & Hwang, 2002).

Numerous studies identified levels of stress and coping strategies used by university students. It was reported that nursing students face more clinical

and academic stressors throughout their training period, as compared to students in other health-related disciplines, such as pharmacy, dentistry, physical therapy and medicine (Beck et al., 1997; Mohamed & Ahmed, 2012; Stecker, 2004). It has also been reported that the nursing students find the clinical component more stressful than the theoretical component of education (Eifried, 2003; Pulido‐Martos, Augusto‐Landa, & Lopez‐Zafra, 2012; Sharif & Masoumi, 2005; Sheu et al., 2002).

High levels of stress not only compromise the delivery of patient care but also affect the health and clinical practice of nursing students. It could also result in inadequate coping mechanisms which could be an obstacle in dealing with the challenges of the nursing profession (Singh, 2011; Lewis & Shaw, 2007). Although stressors and stress cannot be avoided, the ability to cope with them plays a key role in achieving success as a nurse. On the other hand, failure to resolve stress in the long term could have potential professional and personal consequences (Nicholl & Timmins, 2005).

Determining stress and coping strategies among nursing students will have important implications for the nursing profession. It will help in creating supportive learning environments, improving student learning, and enhancing nursing practice and patient care (Del Prato et al., 2011; Pulido‐Martos et al., 2012).

There is ample literature on this subject from within western countries. After a systematic review of 23 studies, Pulido‐Martos et al., (2012) concluded that most of the studies on this subject have been done in Europe and England. However, there is limited literature in the Asian world. The studies conducted in western countries may not be applicable to Asia because of the context. Therefore, this paper will synthesize the evidence regarding stress and coping of nursing students from Asian countries.

2. Purpose:

The purpose of this paper was to critically review and appraise existing literature and identify data gaps regarding stress and coping strategies among nursing students in the Asian context. This integrated literature review will also suggest areas of future research.

3. Critical Appraisal:

High-stress levels can directly or indirectly impede students' academic learning, performance, and health (Kaur et al., 2009; Labrague, 2014). If the stress is not dealt with effectively, it may produce various detrimental effects on the emotional, physical, and social well-being of students (Nancy, 2011; Singh et al., 2011). Understanding levels of stress and coping strategies of the nursing students in Asian countries is critical. This will help in recognizing their abilities to manage their overall health.

3.1. Data Sources and Searches

A comprehensive search of PubMed, EMBASE, Cochrane, CINHAL, ASSIA, PsycInfo, Science Direct, and Google Scholar databases using keywords and different combinations of keywords such as "level of stress, stressors, coping strategies, nursing students, interns, undergraduate nurses" was performed. Most of the studies determined the level of stress and coping strategies used by student and practicing nurses in western countries and were therefore excluded. The literature search was expanded to research gate, websites, reference lists of relevant articles, and Higher Education Commission of Pakistan's Electronic Library. The search limit was focused on Asian countries and limited studies were found in this area.

3.2. Article Selection

Initially, 25 articles were selected after reading the titles and abstracts. The inclusion criteria for final selection was: (i) the studies conducted in the Asian context (ii) the studies included nursing students or interns as samples, (iii) and the study included one or more data collection instruments. The final selection of these studies was done after critical reading of the complete article considering the identification of major themes and findings.

3.3. Overview of the Results

Nine studies conducted between 2007 and 2014 from India, Pakistan, Iran, Philippines, Hong Kong, and Jordan met the inclusion criteria. The summary of these studies is provided in Table I. The detailed findings and critique of these studies are reported in following subsections.

3.4. Study Purpose, target population and setting

Most of the studies determined the levels of stress and coping strategies among baccalaureate nursing students (Chan, So, & Fong, 2009; Kaur et al., 2009; Khater, Akhu-Zaheya, & Shaban, 2014; Nancy, 2011; Prasad et.al, 2013; Seyedfatemi, Tafreshi, & Hagani, 2007; Labrague, 2014; Sikander & Aziz, 2012) except one by Singh et al., (2011). The target population of this study was nursing interns of the Institute of Nursing Education in Chandigarh, India (Singh, S. Sharma, & R. Sharma, 2011).

Chan et al., (2009) and Labrague (2014) excluded the first year nursing students because of lack of clinical experience. Prasad et.al, (2013) only

conducted their study on first year nursing students at Yenepoya Nursing College, Mangalore, India.

Each of these studies clearly stated its purpose and setting. However, the inclusion and exclusion criteria for study samples was not explicitly stated. Seven studies identified both clinical and academic stress levels. Only Khater et al., (2014) and Chan et al., (2009) identified the clinical stress levels of nursing students in Jordan and Hong Kong respectively.

3.5. Conceptual/Theoretical framework

Kaur et al., (2009) based their study on Lazarus and Folkman's Stress, Appraisal, and Coping theory (1984). The rest of the studies did not use any conceptual/theoretical framework but clearly defined the study variables. Sikander & Aziz (2012) neither used any framework nor clearly defined the study variables.

3.6. Study methodology

This review showed that the majority of studies were descriptive in nature. Only Sikander and Aziz (2012) used an analytical cross-sectional design. The commonly used instruments were Perceived Stress Scale (PSS), Adolescent Coping Orientation for Problem Experiences Inventory (ACOPE), Physio-Psycho-Social Response Scale, Stress and Coping Inventory of Lazarus and Folkman (1984) and Coping Behavior Inventory developed by Sheu et al., (2002). Seven studies used PSS (Chan, So, & Fong, 2009; Prasad et.al, 2013; Nancy, 2011; Seyedfatemi et al., 2007; Labrague, 2014; Khater et al., 2014; Singh et al., 2011). Three studies utilized Physio-Psycho-Social Response Scale (Chan, So, & Fong, 2009; Labrague, 2014; Singh et al., 2011). Two studies used ACOPE (Nancy, 2011; Seyedfatemi et al., 2007) and one study used Stress and Coping Inventory of Lazarus & Folkman (Sikander & Aziz, 2012) and Coping Behavior Inventory (Chan, So, & Fong, 2009). Kaur et al., (2014) and Singh et al., (2011) also developed new self-administered questionnaires for measuring stress and coping. These two studies, in addition to Sikander and Aziz (2012), did not ensure the validity and reliability of the instruments and no pilot testing was done before the use of instruments. Some of the studies used Cronbach's alpha method for ensuring the reliability and expert opinion for validity of the instruments (Prasad et.al, 2013; Labrague, 2014).

3.7. Data analysis

All of these studies used both descriptive and inferential statistics for data analysis. The commonly used statistical tests were T-Test, ANOVA, and Friedman test. The rationale for using these tests was explicitly stated. However, none of the studies applied the normality test which should have been done because of the small sample size. Furthermore, some of the studies also applied correlation and regression analysis to find out the association among stress, coping, and the demographic variables (Khater et al., 2014; Labrague, 2014; Prasad et.al, 2013; Chan et al., 2009)

4.8. Ethical considerations

The majority of the studies obtained ethical approval from their respective institutional review boards. Informed consent was obtained from the participants and necessary steps were taken to ensure their confidentially and anonymity. Kaur et al., (2009), Singh et al., (2011), and Nancy (2011) did not obtain ethical approval.

4. Key findings:

It was challenging to compare results among these studies because of a great number of stressors, coping strategies, and use of different tools. Therefore, the key findings are reported in terms of subsequent themes such as levels of stress, common stressors, coping strategies, and association among stress, coping, and demographic variables.

4.1. Level of Stress

Most of the studies revealed that the nursing students and interns experience moderate stress during their academic and clinical studies (Chan, So, & Fong, 2009; Sikander & Aziz, 2012; Singh et al., 2011; Kaur et al., 2009; Labrague, 2014; Nancy, 2011; Khater et al., 2014). These studies employed a small convenient sample from a single nursing institution, thereby limiting the generalization of these findings. These researchers did not use any structured method such as power analysis for sample size estimation. Khater et al., (2014) used a large sample of 597 nursing students and applied power analysis for sample size calculation. However, the use of convenient sampling and data collection from only two institutions limits the generalization.

In contrast, Prasad et.al, (2013) reported a mild level of stress among students of Yenepoya Nursing College Mangalore, India but did not provide any explanation for this finding. Kaur et al., (2009) utilized the stress and coping theory of Lazarus and Folkman (1984), but they used self-administered and non-valid and non-reliable data collection tools. These factors limit the generalization of these findings.

All of the reviewed studies used a self-administered questionnaire which could have led to reporting bias. Also, respondents could have

answered in a socially desirable manner. This limitation was acknowledged in all of the studies.

Most of the studies reported that first year nursing students experience more stress than senior students because of exposure to new and unfamiliar environments (Kaur et al., 2009; Khater et al., 2014; Nancy, 2011; Prasad et.al, 2013; Seyedfatemi et al., 2007). In contrast, Sikander and Aziz (2012) conducted their study at Shifa College of Nursing Islamabad, Pakistan and found that second-year students experience higher stress than other years due to an increase in both theory and clinical workload.

4.2. Common Stressors

The most commonly stated academic stressor was assignment workload (Kaur et al., 2009; Khater et al., 2014; Nancy, 2011; Seyedfatemi et al., 2007; Labrague, 2014; Sikander & Aziz, 2012) whereas the commonly reported clinical stressors were lack of knowledge, inadequate training, and long clinical hours (Chan et al., 2009; Kaur et al., 2009; Labrague, 2014; Seyedfatemi et al., 2007; Sikander & Aziz, 2012). Singh et al., (2011) and Labrague (2014) reported that stress affected the emotional and behavioral health of the Indian and Filipino students. However, Sikander and Aziz (2012) reported that the stress mainly influenced the social life of the Pakistani students.

4.3. Coping Strategies

The majority of studies reported that students used more positive coping strategies than negative strategies. The most common positive coping strategies were problem-solving, transference, optimism, seeking family and professional support, and leisure activities (Chan et al., 2009; Khater et al., 2014; Seyedfatemi et al., 2007; Sikander & Aziz, 2012;). The most commonly reported negative coping strategies were crying and isolation (Kaur et al., 2009; Nancy, 2011).

4.4. Association among Stress, Coping, and Demographic Variables

Four out of nine studies determined an association of stress and the demographic variables. Nancy (2011), Sikander and Aziz (2012), and Prasad et.al, (2013) found no association among the demographic variables and levels of stress. However, Labrague (2014) and Khater et al., (2014) reported that student's age is negatively associated with the stress level.

5. Discussion: Direction for Future Research:

This review illustrated that the dynamic nature of stress has not been adequately investigated in the current literature. The overall strength of these studies is weak because of the discussed limitations and the cross-sectional design. Although most of the studies used structured data collection tools, these structured measures may limit the in-depth understanding of stress and coping of nursing students. Therefore, more studies are required in the Asian countries particularly Pakistan, to address this problem.

Stress levels of nursing students may change over time or across situations due to the transitional nature of nursing education. Similarly, coping strategies change from one stage of a complex stressful experience to another (Lazarus, 1993). Most of the studies determined level of stress and coping strategies among nursing students at single point in time. There is limited evidence how these levels can change over time and under different conditions. Future studies should measure this phenomenon using a mixed-method design or a longitudinal design. A longitudinal study can also validate the findings concerning levels of stress across different academic years. This is consistent with the findings from some of these studies that stress and coping strategies might vary at different points in time because of the transitional nature of nursing students' life (Khater et al., 2014; Seyedfatemi et al., 2007).

There was variability in the use, structure, and content of data collection instruments. The instruments had 14-66 items for determining the academic and clinical stress levels and coping strategies among nursing students. This shows heterogeneity in the ways of reporting the stressors. Future research should establish or refine standardized instruments for measurement of stress and coping.

These studies reported that most of the demographic variables, except age, are not associated with the students' levels of stress. Future correlational studies for exploring the relationship of the demographic variables and levels of stress could be conducted to validate/refute this finding.

Sample sizes were varied in these studies. This inferred that the generalizability of these findings is limited because greater power cannot be achieved. If future cross sectional study is desired, then it should use a larger and random sample. The sampling should be done from various nursing institutions of a particular country. It should also be based on a conceptual/theoretical framework in order to guide more structured inquiry of the variables.

6. Limitations of the review:

The heterogeneity of the reviewed studies in terms of sample characteristics, data collection tools, and the operational definitions of the study variables may have led to difficulties when attempting to generalize the results. Inclusion of only nine studies

from few Asian countries and four studies from India only may impede a comprehensive understanding of the subject in Asian context.

7. Conclusion:

This review underlined the strength and limitations of the studies identifying the levels of stress and coping strategies of nursing students in Asian context. A number of methodological limitations were found in these studies indicating that this topic has not been adequately investigated. Therefore, further research is needed to expand the literature in this area. The findings of this paper also presents suggestions for future research to the nursing researchers and educators.

Corresponding Author:
Ahtisham Younas, M.N.(c)
Memorial University of Newfoundland and Labrador, St John's, Canada.
E-mail: ay6133@mun.ca, &
ahtishamyounas66@gmail.com

References

1- Beck, D. L., Hackett, M. B., Srivastava, R., McKim, E., & Rockwell, B. (1997). Perceived level and sources of stress in university professional schools. *Journal of Nursing Education*, 36(4), 180-186.
2- Chan, C. K., So, W. K., & Fong, D. Y. (2009). Hong Kong baccalaureate nursing students' stress and their coping strategies in clinical practice. *Journal of Professional Nursing*, 25(5), 307-313.
3- Del Prato, D., Bankert, E., Grust, P., & Joseph, J. (2011). Transforming nursing education: a review of stressors and strategies that support students' professional socialization. *Advances in Medical Education and Practice*, 2, 109.
4- Eifried, S. (2003). Bearing witness to suffering: The lived experience of nursing students. *Journal of Nursing Education*, 42(2), 59-67.
5- Kaur, S., Das, K., Amrinder, N., Kanika, S., Meena, P., Gagandeep, I., & Arash, R. (2009). Stress and coping in the nursing students. *J Ment Health Hum Behav,* 14(1), 51-6.
6- Khater, W., Akhu-Zaheya, L., & Shaban, I. (2014). Sources of stress and coping behaviors in clinical practice among baccalaureate nursing students. *International Journal of Humanities and Social Science*, 4(6), 194-202.
7- Labrague, L. J. (2014). *Stress, stressors, and stress responses of student nurses in a government nursing school.*
8- Lazarus, R. S. (1993). From psychological stress to the emotions" *a History of Changing*.
9- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* Springer publishing company.
10- Mohamed, B. M., & Ahmed, E. S. (2012). Perception of nursing students towards clinical stressors in the Faculty of Applied Medical Sciences-Al Jouf University-Saudia Arabia. *Journal of American Sciences*, 8, 608-617.
11-Nancy, R. K. (2011). Stress and coping strategies among nursing students. *Nursing Midwifery Research Journal*, 7, 141-51.
12- Nicholl, H., & Timmins, F. (2005). Programme ‐ related stressors among part ‐ time undergraduate nursing students. *Journal of Advanced Nursing,* 50(1), 93-100.
13-Ortqvist, D. & Wincent, J. (2008). Prominent consequences of role stress: a meta-analytic review. *International Journal Stress Management*, 13(4), 399–422
14- Prasad, C. V., Suresh, A., Thomas, D. K., Pritty, M. K., Beebi, S., & Multazim, V. (2013). The level of stress and coping mechanism adopted by I Year B. Sc. nursing students. *Archives of Medicine and Health Sciences,* 1(1), 19.
15-Pulido ‐ Martos, M., Augusto ‐ Landa, J. M., & Lopez ‐ Zafra, E. (2012). Sources of stress in nursing students: a systematic review of quantitative studies. *International Nursing Review,* 59(1), 15-25.
16-Schneiderman, N., Ironson, G., & Siegel, S. D. (2005). Stress and health: psychological, behavioral, and biological determinants. *Annual Review of Clinical Psychology,* 1, 607-628.
17- Seyedfatemi, N., Tafreshi, M., & Hagani, H. (2007). Experienced stressors and coping strategies among Iranian nursing students. *BMC nursing,* 6(1), 1.
18-Sharif, F., & Masoumi, S. (2005). A qualitative study of nursing student experiences of clinical practice. *BMC Nursing,* 4(1), 6.
19-Sheu, S., Lin, H. S., & Hwang, S. L. (2002). Perceived stress and physio-psycho-social status of nursing students during their initial period of clinical practice: the effect of coping behaviors. *International Journal of Nursing Studies*, 39(2), 165-175.
20-Sikander, S., & Aziz, F. (2012). Stressors and coping strategies among baccalaureate nursing students at Shifa College of Nursing Islamabad, Pakistan. *International Journal of Nursing Education*, 4(2), 193-197.
21-Singh, C., Sharma, S., & Sharma, R. K. (2011). Level of stress and coping strategies used by nursing interns. *Nursing and Midwifery Research Journal,* 7 (4), 152-160.

22- Walton, R. L. (2002*). A comparison of perceived stress levels and coping styles of junior and senior students in nursing and social work programs* (Doctoral dissertation, Marshall University Huntington).

Received March 02, 2016; revised March 08, 2016; accepted March 11, 2016; published online April 01, 2016.

Appendix

Table I: *Summary of the Reviewed Studies*

Authors & location of research	Purpose	Sample size	Study design	Instrument	Strengths and Limitations
Sikander and Aziz (2012) Islamabad, Pakistan	Determine the stressors and coping strategies in nursing students studying at Shifa college of Nursing, Islamabad, Pakistan.	78	Analytical Cross-Sectional	Stress and coping inventory of Lazarus & Folkman (1984).	The study is considered one of the initial studies exploring stress among nursing students. Therefore, it serves as baseline for future studies. The sample size was small and convenient. The study variables were not explicitly defined. The psychometric properties of research instrument were not tested. There may be a conflict of interest as the researchers were the faculty members of the same institution.
Prasad, Suresh, Thomas, Pritty, Beebi, and Multazim (2013) Yenepoya Nursing College, Mangalore, India	The study aimed to determine the level of stress and coping mechanisms adopted by I Year B.Sc. nursing students.	60	Descriptive Cross-Sectional	Perceived stress scale, Structured coping scale, and Socio-demographic proforma.	The study was conducted by novice researchers (Fourth Year nursing students). The sample size was small and convenient. The Normality test was not applied before using parametric tests.
Nancy (2011) A private nursing institute of Punjab affiliated with Baba Farid University of Health sciences, Faridkot, India	To assess the stress level and coping strategies used by nursing students.	180	Descriptive Cross-Sectional	Perceived Stress Scale -14 and ACOPE.	The study was not approved from Ethical Review board. Permission was only taken from the college authority. The psychometric properties of research instrument were not tested and no pilot study was undertaken. The sample size was small and convenient. The study variables were not explicitly defined. The Normality test was not applied before using parametric tests.

Chan, So, and Fong, (2009) Hong Kong	To examine Hong Kong baccalaureate nursing students' stress and their coping strategies in clinical practice.	205	Descriptive Cross-Sectional	Perceived Stress Scale, Physio Psycho–Social Response Scale, and Coping Behavior Inventory.	The sample size was small and convenient. The study variables were not explicitly defined. The Normality test was not applied before using parametric tests.
Singh, S. Sharma, and R. Sharma (2011) National Institute of Nursing Education in Chandigarh, India	To find out the level of stress and coping strategies used by nursing interns of National Institute of Nursing Education, PGIMER, Chandigarh.	44	Descriptive Cross-Sectional	Stress scale, Perceived Stress Scale, and Physio-psycho-social response scale	The study was not approved from Ethical Review board. The psychometric properties of research instrument were not tested and no pilot study was undertaken. Expert opinion was sought to ensure validity and reliability of data collection instruments. The sample size was small and convenient. The study variables were not explicitly defined. The Normality test was not applied before using parametric tests.
Seyedfatemi, Tafreshi, and Hagani (2007) Iran Faculty of Nursing & Midwifery	To identify sources of stress in nursing students and to determine how they cope with stressful events.	366	Descriptive Cross-Sectional	Student Stress Survey and ACOPE.	The sample size was small and convenient. The study variables were not explicitly defined. The Normality test was not applied before using parametric tests.
Labrague (2014) Philippines	The aim of the study was to identify the level of stress, common sources of stress, and physio- psycho-social responses to stress and to identify the determinants of stress among student nurses enrolled in a government nursing school.	61	Descriptive cross-sectional	Perceived Stress Scale and Physio Psycho–Social Response Scale.	The sample size was small and convenient. The Normality test was not applied before using parametric tests.
Khater, Akhu Zaheya, and Shaban (2014) Northern Jordan	The purpose of this study is to assess stress level and sources of stress among nursing students in Jordan, as well as identifying the coping strategies utilized by nursing students.	597	Descriptive cross-sectional	Perceived Stress Scale and Coping Behavior Inventory	Power analysis was used for sample size estimation. The study variables were not explicitly defined. The sample size was convenient. The Normality test was not applied before using parametric tests.

Kaur, Das, Amrinder, Kanika, Meena, Gagandeep, and Arash, (2009). India	The purpose of the study was to identify the stressors and coping strategies of baccalaureate nursing students at one of the premier institutes of the country.	205	Descriptive cross-sectional	Newly developed self-administered questionnaire to assess stress and coping strategies	The study was based on Stress and Coping Theory of Lazarus and Folkman (1984). The study was not approved from Ethical Review board. The psychometric properties of research instrument were not tested and no pilot study was undertaken. The questionnaires used were not valid and reliable. The sample size was small and convenient. The study variables were not explicitly defined. The Normality test was not applied before using parametric tests.

Anaerobic Digestion of Cow Dung with Rumen Fluid

J. T. Oladeji[1*] • E. O. Olafimihan[2] • O. E. Itabiyi[3]

Department of Mechanical Engineering, Faculty of Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
jtoladeji@lautech.edu.ng

Abstract: Production of biogas from agricultural and animal wastes is one of the viable options to mitigate the scarcity of energy and hazards of fossil fuels to both human and ecology. Therefore, this project work was on generation of biogas using cow dung and rumen fluid as co-substrate. A biogas digester with a capacity of 105 liters was used to produce the gas. The substrate (cow dung and rumen fluid) was mixed in the ratio 3:2 and water to substrate ratio of 2:1 was used. The digester was stirred thrice daily to avoid scum formation in the digester and to allow for easy escape of the gas produced. The retention time used for this experiment was 42 days during which the daily internal temperature readings were taken in order to determine temperature variations and also to determine the effect of heat on the production rate. A rubber hose was connected to the digester gas outlet located at the top of the digester and the other end of the rubber hose was connected to a PVC Tyer tube provided for storing the gas generated. The gas produced was collected and taken to the laboratory for chemical analysis. The results showed that biogas yielded consists of 57.98 % of methane (CH4), 39.99 % of carbon dioxide (CO2), 0.10 % of oxygen (O2), 0.01 % of hydrogen sulphide (H2S) and 0.01% of water vapour. The methane has the highest percentage, which represents the main source of energy and oxygen having 0.10 %, which shows that the process was purely carried out under anaerobic condition. Result of this study showed that methane has the highest percentage and generally cow dung with rumen fluid easily lent itself to process of anaerobic digestion.

To cite this article
[Oladeji, J. T., Olafimihan, E.O., & Itabiyi, O.E. (2016). Anaerobic Digestion of Cow Dung with Rumen Fluid. *The Journal of Middle East and North Africa Sciences*, 2(4), 58-60]. (P-ISSN 2412- 9763) - (e-ISSN 2412-8937). http://www.jomenas.org. **8**

Keywords: Anaerobic digestion, bio-gas, biomass, animal residues, methane.

1. Introduction:

Agricultural residues and animal wastes are increasingly being diverted for use as domestic fuel to displace fossils fuel and reduce environmental pollution and reduce emission of greenhouse gases (Aremu and Agarry, 2013). Agricultural residues in their natural forms will not bring a desired result because, they are mostly loose and of low-density materials in addition to the fact that their combustion cannot be effectively controlled (Oladeji, 2011). Bio-residues are a major contributor to greenhouse gas emissions and pollution of water courses if not managed properly (Eze and Ojike, 2012).

Agricultural residues and even animal wastes can be degraded anaerobically in a biogas digester for production of biogas. Biogas is essentially a mixture of methane and carbon dioxide, produced by the breakdown of organic waste by bacteria without oxygen (anaerobic digestion). It contains methane and carbon dioxide oxide with traces of hydrogen sulphide and water vapour. It burns with pale blue flame and has a calorific value of between 20 – 30 J/m3 depending on the percentage of methane in the gas (Sagagi, et al., 2009). Biogas production is a profitable means of reducing or even eliminating the menace and nuisance of urban wastes in many cities in Nigeria (Sagagi, et al.2009). Consequently, biogas can be utilized in all energy consuming applications designed for natural gas.

The techniques used for the conversion of organic materials to biogas have been in existence for many years (Kerertic and Archana, 2012). Biogas generation has been applied to meeting the energy needs in rural areas as it is being done in England, India and Taiwan. In the United States, there has been considerable interest in the process of anaerobic digestion as an approach to generating a safer clear fuel as well as source of fertilizer (Garba and Sambo, 1995).

The use of rural wastes for biogas generation, rather than directly used as a fuel or fertilizer, offers several benefits such s the production of energy resource that can be stored and used more efficiently, the production of sludge that retains the fertilizer value of the original material and the saving of energy required to produce equivalent amount of nitrogen-containing fertilizer by synthetic process (Salunkhe, et al., 2012).

The amount of gas produced through anaerobic digestion is a function of the size of the bio-digester,

its feeding regime, type of substrate and environmental conditions such as ambient temperature. The biogas consists of mainly of methane, carbon dioxide, hydrogen sulphide, and traces of water vapour. To have more energy per unit volume of biogas, the carbon dioxide as well as hydrogen sulphide (H2S) contents as well should be removed as they may deteriorate compression system due to their corrosive property.

2. Material and Methods:

The choice of feed stocks for this project was cow dung and rumen fluid as co-substrate due to the excess abundance of cattle in Nigeria and its numerous advantages. This is also in line with the findings of Liedl (2006) that residues from animal and poultry are the ideal substrates for bio-digesters because they are not acidic. The cow dung and rumen fluid used in this study were obtained from slaughter house located closed to the University. The fresh cow dung was obtained from animal holding pen unit while rumen fluid was collected from evisceration unit. The cow dung and rumen fluid were mixed in the ratio 3:2 and were analyzed based on its dry matter (DM) content by heating them at 105o C and 550o C, respectively. The substrate was properly mixed with water in the ratio 1:2. To facilitate the anaerobic digestion of the substrate, a 105-litre biogas digester (Plate 1), which essentially consists of the digestion chamber, the substrate inlet duct, and the gas and slurry outlet ducts among others was fabricated and was fed with the substrate.

The digester was stirred three times daily to avoid scum formation and to allow for easy escape of the gas produced. The retention time used for this experiment was 42 days (6 weeks) during which the internal temperature readings were taken with the aid of mercury thermometer in order to determine the temperature variations and also to determine the effect of heat on the production rate. A rubber hose was connected to the digester gas outlet located at the top of the digester and the other end of the rubber hose was connected to PVC tube provided for storing the gas generated. The gas produced was taken to laboratory for further chemical analysis.

3. Results and Discussion:

Table 1shows the results of chemical properties of the substrates before anaerobic digestion took place, while Tables 2 and 3depict the composition of biogas produced and average weekly temperature readings respectively.

Plate 1. A Biogas Plant Set-up

Table 1: *Chemical properties of the substrates before digestion Legend*

Parameters Determined	Replicates 1	2	Average
% D.M at 105oC	23.85	23.83	23.84
% O.D.M at 550oC	72.34	72.36	72.35
NH4-N (g/kg)	17.84	17.89	17.86
Nitrogen (g/kg)	41.18	41.13	41.15
% K on DM	1.56	1.58	1.57
Phosphorus (g/kg)	3759.00	3756.00	3757.50
% C. F	11.48	11.51	11.495
% Lignin	4.80	4.60	4.70
% O.C	31.56	31.59	31.575
PH	5.67	5.63	5.65

(i) D.M: - Dry Matter (ii) O.D.M: - Organic Dry Matter (iii) NH4-N: Ammonium – Nitrogen (iv) K: - Potassium (v) C.F: - Crude fibre (vi) O.C: - Organic Content

Table 2: *Biogas composition based on chemical analysis*

Substance	Formula	Percentage (%)
Methane	CH4	57.98
Carbon dioxide	CO2	39.99
Nitrogen	N	0.60
Water vapour	H20	0.20
Oxygen	O2	0.10
Hydrogen sulphide	H2S	0.01

Table 3: *Average weekly temperature readings for biogas Production*

Hydraulic Retention Time (Weeks)	Temperature (o C)
1	30.50
2	31.00
3	33.50
4	32.50
5	33.00
6	30.00
Average	31.75

The biogas yielded consists of 57.98 % of methane (CH4), 39.99 % of carbon dioxide (CO2), 0.10 % of oxygen (O2), 0.01 % of hydrogen sulphide (H2S), and 0.01 % of water vapour. The methane has the highest percentage, which represents the main source of energy and oxygen having 0.01 %, which shows that the process was purely carried out under anaerobic condition (in the absence of oxygen).

4. Conclusion:

From the study, the following conclusions were drawn: Cow dung co-digested with rumen fluid easily lent itself to process of anaerobic digestion. Methane has the highest percentage gas generation. Biogas can be produced by the microbial digestion of organic matter in the absence of air. Biogas production took place within the retention period of six weeks from microbial digestion of cow dung and rumen fluid in an anaerobic condition.

Corresponding Author:
J. T. Oladeji,
Department of Mechanical Engineering, Faculty of Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.
E-mail: jtoladeji@lautech.edu.ng

References

1. Aremu, M. O., & Agarry, S. E. (2013). Enhanced biogas production from poultry droppings using corn-cob and waste paper as co-substrate. *International Journal of Engineering Science and Technology*, 5(2), 247-253.
2. Eze, J. I., & Ojike, O. (2012). Anaerobic production of biogas from maize wastes. *International Journal of Physical Sciences*, 7(6), 982-987.
3. Sambo, A. S., Garba, B., & Danshehu, B. G. (1995). Effect of some operating parameters on biogas production rate. *Renewable Energy*, 6(3), 343-344.
4. Chowdhary, K. K., & Chowdhary, A. K. (2012) *Bio-Energy Generation: A Sustainable Environmental Technology for Waste Management*.
5. Bhagat, M. S. K., Tiyasha, M., & Rani, M. M. (2006*). Biogas production potential of Poultry waste and Jatropha de-oiled cake.*
6. Oladeji, J. T. (2011). Agricultural and Forestry Wastes and Opportunities for their use as Energy Source in Nigeria-An Overview. *World Rural Observations*, 3(4), 107-112.
7. Sagagi, B., Garba, B., & Usman, N. (2009). Studies on biogas production from fruits and vegetable waste. *Bayero Journal of Pure and Applied Sciences*, 2(1), 115-118.
8. Ugoji, E. O. (2010). Production of biogas from starchy wastes. *Journal of Scientific Research and Development*, 12(1).
9. Tokan, A., Sambo, A. S., Jatau, J. S., & Kyauta, E. E. (2012*). Effects of Particle Size on the Thermal Properties of Sawdust, Corncobs and Prosopis Africana Charcoal Briquettes*.

Received March 02, 2016; revised March 10, 2016; accepted March 11, 2016; published online April 01, 2016.

The Journal of Middle East and North Africa Sciences

Monthly Journal Online

Publisher: JOMENAS Press

Address: Anwar St. PO Box 11415, Amman, Jordan.

Telephone: +962-6-5050852.

Emails: editorsmenaj@gmail.com / jmenas2015@gmail.com

Website: http://www.jomenas.org