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The Reduction of Carbohydrate, Fat and The Increment of Protein Content of Some Nigerian Diets by Traditional Fermentation

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Abstract: Fermentation is vital to African food processing. Its effects on the percentage carbohydrate, proteins, lipid and moisture composition of laboratory prototypes of the fermented seed from Parkia biglobosa, (Dawadawa) condiment paste, fermented milk (Nono), corn (Zea mays)-based pap (Akamu), soybean (Glycine max) based-cheese paste (wara) and soy-milk (soymilk). The major macro-nutrient and moisture contents of each food product and their respective substrates were determined using standard methods and compared. The result showed that there was a noticeable fall in the carbohydrate content in the Corn (56.23±9.09 %) as it was converted to Akamu (7 .63±2.67 %) just as was noticed in the fermentation of Nono (11.99±2.67 %) from fresh cow milk (42.3±1.60 %). The similar trend was also found in the fermentation of the lipid-containing soy bean seed (41±7) to soy wara (7.6±2 %) and soymilk (5.6±2.2 %). However, there was an increase in the protein content from the fermentation of Parkia biglobosa seed: 31.62±0.83 - 34.17±3.6 % in Dawadawa and 25.25±0.59 - 37.74±1.8 % in Nono. Moisture contents of the various fermented food products also increased as follows: from 9.00 ±0.01-90.0±0.70 in Akamu; 89.0±0.58 into 92.7±0.98 in Nono, 13.0±0.87 -33±0.01 in Dawadawa paste, and 5.0±0.01 - 39±1.41 % in soy milk and 31 ±1.4 % in soy wara. These show that fermenting foods could reduce their carbohydrate and fat content relatively but increase their protein content. These cannot be overemphasized considering the problem of malnutrition which is prevalent around this part of the world.
Keywords: Fermentation; Carbohydrate; Protein; Lipid

INTRODUCTION

Food is a material that provides living things with the nutrients they need for energy and growth (WHO, 2012). It is usually of plant or animal origin. Food nutrients include carbohydrates, protein, lipids (which are macronutrients and), vitamins, minerals, and water (which is of no caloric value). Food nutrients contained in different diets; the sum of food consumed by a person or other organism (Andrew et al., 2014,; Chandra et al., 2015, Zygmunt et al., 2009).

The diets people eat, in all their cultural variety, define to a large extent people's health, growth, and development (UNICEF, 2016, WHO, 2012). Although fermenting foods traditionally have constituted a significant proportion of our diets, Nigerians have exhibited an ambivalent attitude regarding consumers' taste and preferences for food (Osho et al., 2010). The introduction of foreign high technology products especially processed ones radically changed the Nigerian food culture into a mixed grill of both foreign and local dishes (Ojo, 1991); Sold at relatively high prices, these imported (highly processed) items now command respect (irrespective of the accompanying nutritive hazards). This worsened by the harsh economic condition ravaging the country(Ameh, 2018).

Fermented foods remain of interest since they do not require refrigeration during distribution and storage (Osho et al., 2010) due to the biochemical changes in them that support their natural preservation. They do not require any severe specialization, training or the use of any advanced technology (Steinkraus, 1997) that could command the involvement of scarce resources in a developing economy like ours. Fermented foods can bring many benefits to people in developing countries.

Fermented foods play an important role in providing food security, enhancing livelihoods and improving the nutrition and social well being of millions of people around the world, particularly, the marginalized and vulnerable (FAO, 2011). Fermentation processes also play important roles in food technology in developing countries (UNICEF, 2016).

In traditional fermentation processes, natural micro-organisms employed in the preparation and preservation of different types of food (Robert 2011). These processes add to the nutritive value of foods as well as enhancing flavor and other desirable qualities associated with digestibility and edibility. The fermentation techniques often characterized by the use of simple, non-sterile equipment, chance or natural inoculum, unregulated conditions, etc. Nigeria is endowed with a wide range of fermentable indigenous staple foods that (can) serve as raw materials for agro-allied cottage industries.

During the fermentation process, microbial growth and metabolism result in the production of a diversity of metabolites (FAO, 2004). According to Achi (2005) and Ajibola et al., 2016, food fermentation is regarded as one of the oldest ways of food processing and preservation. Fermented foods classified as fermented starchy foods (e.g. Pito, Burukutu, Obiolor from cassava root or tuber); fermented cereal-based foods (e.g. Ogi and Kunuzaki or cereal-based fufu); Alcoholic beverages (e.g. Pito, Burukutu, Obiolor); fermented legumes and oil seeds (e.g. Dawadawa, Iru, Ogiri, Okpiye); and fermented animals proteins (e.g. Nono and Yoghurt) based on their content of the major nutrients, carbohydrates, proteins and lipids (Egwim et al., 2013).

According to Dorota and Danatu, 2018; Robert, (2011); Latunde-Dada, (2011); Steinckraus(1995); the role of fermentation in nutrient availability of food may summarize into five main purposes: Enrichment of the diet through development of a diversity of flavors, aromas, and textures in food substrate. Preservation of substantial amounts of food through lactic acid, alcohol, acetic acid, and alkaline fermentations. Biological enrichment of food substrates with protein, amino acids essential fatty acids and vitamins as in dawadawa. Elimination of antinutrients (example in garri production), and a decrease in cooking times and fuel requirement as found (Chikeze and Ojiako, 2013).

It is noteworthy that in a developing economy like ours faced with serious challenges like economic depression, poverty as well as increased food crises and prevalence of food-related diseases especially diseases related to energy malnutrition (Ameh, 2018, FAO, 2011a, Anthony, et al., 2011). It is necessary to investigate some of the effects mentioned above of traditional fermentation processes on the energy-rich macronutrients (carbohydrates, lipids, and proteins) content of some fermented foods common to the Nigerian State. Since the tradition fermentation process is cheap, a positive evaluation could, therefore, be valuable.

MATERIALS AND METHODS

Sample Collection and Treatment

Samples of dry corn (Zea mays) and soybean (Glycine max) bought in Bosso local market, samples of Parkiabiglobosaseed bought from Kure market, a Fresh milk sample bought from the Fulani camp site near Bosso Dam-all from Minna, Niger state. Prototypes of the foods were produced in the laboratory using the traditional methods of fermenting foods in Niger state.

Solid (dry) samples of corn (Zea mays), Parkia biglobosa, and soy bean (Glycine max) seeds were pounded to powder and sieved, and the filtrates collected. Dawadawa Pastes also homogenized by pounding using a mortar and pestle.

The dry samples were preserved in laboratory cupboards at room temperature while the wet samples were refrigerated.

Corn (Zea mays) and its product (pap or Akamu), fresh milk (Kindurumu) and Nono were analysed for their carbohydrate content. Parkiabiglobosa, Dawadawapaste, Kindurumu, and Nono were analyzed for proteins. Soy bean seed (Glycine max), soy-cheese (wara) and milk were analyzed for lipids. The carbohydrates, lipids, protein and moisture contents before and after the fermentation process thus taken. The flow chart below shows the traditional methods used in processing the substrates (raw materials) to the various finished food products.

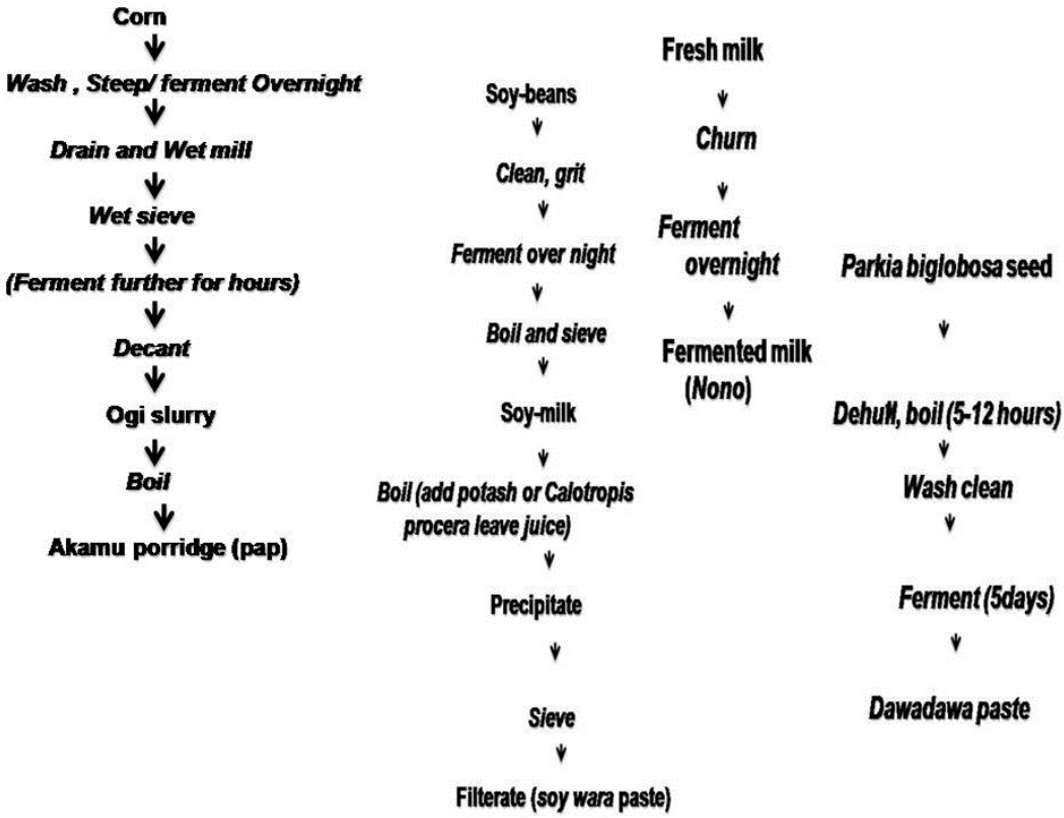

Figure 2. Flow chart for the traditional fermentation processes use

Apparatus

The apparatus used for the analyses of the samples include Gallenkamp Hotbox oven (size2), Brainweigh B modeled Weighing balance, table top bucket centrifuge and double beam spectrophotometer (UV. 2800 model).

2.3.0 Determination of Total Carbohydrates (As Sugars)

The method for determining the effect of traditional fermentation processes on carbohydrate foods is the DNS colorimetric method as described by Ceinwyns, (1998). 0.2g of each sample weighed into a boiling tube, Cooled and 12ml of 10% NaOH carefully added. It was Mixed and filtered into a 100ml volumetric flask, washing the tube into the flask with distilled water. And there was made up to volume with distilled water and mixed well by inversion. Standard glucose solutions of 0.25, 0.5 0.75, 1.0, 1.25 and 1.5 mg glucose per ml by dilution of the stock glucose solution containing 15mg/ml, using distilled water and 100ml volumetric flasks prepared.1.0ml of distilled water pipetted into a test tube (blank) and 5 other labeled test-tubes. 1.0 ml of each standard glucose solution was pipette (0.25mg-1.5mg).DNS reagent (1.0ml) and 2.0ml water to each tube using pippetes was added. The sample (1.0ml) prepared above was pipetted and 2.0ml water and 10ml DNS reagent was added. All tubes were heated in a boiling water bath for 5min to allow the reaction between glucose and DNS to occur and Cooled, then each volume was adjusted to 20ml accurately with distilled water, using pipettes or a burette, and mixed well. The absorbance of each solution at 540 nm read calculated thus:

Available carbohydrates in cereals (as glucose) = C×10/W

Where C=concentration, in mg of glucose per 20ml, and W=weight of sample used (g).

Protein Determination by Biuret Method

The specific modified method by Amadieet al., (2004) used. Serial dilution of the standard protein solution made: egg albumin in the range 0-2.5 mg/ml. This was done by measuring the standard albumin in the range of 0.0, 0.5, 1, 1.5, 2, and 2.5mg, and with 0.2N of NaOH making them up to 1ml. Biuret reagent (3ml) was added, into each test tube, mixed and warmed for 15minutes at 37oC and cool. The absorbance of each tube measured at 540nm.

Each food sample (1g) introduced into physiological saline (2ml) which further diluted to 1 volume: volume with normal saline.

To 1ml diluted solution was added 0.1% SDS (1ml) and 2ml chloroform was added which was then vortexed for 10 seconds followed by centrifugation at 1800g for 5 minutes.

The extract (supernatant) was taken (1ml), and 4ml biuret reagent added and vortexed and allowed to stand for 20minutes and read at 540nm within 10 minutes and calculated below.

Available proteins in samples (as egg albumin) = C×50/W

Where C=concentration, in mg of glucose per ml, and W=weight of a sample used (1g).

Determination of Total Lipids

The lipid fraction includes fats, phospholipids, sphingolipids, waxes, steroids, terpenes, and fat-soluble vitamins. In real terms fat makes up 99% of the lipid fraction of food; While Bligh- Dyer (1959) technique was used for wet samples (Gregory, 2005); Isopropanol (IPA) determination used for the powdered soy beans described by Lam and Proctor (2001). Soy powder (1g) was vortexed for 4minutes in 5mls of IPA. The extract centrifuged at 2500 revolutions per minute for 10 minutes. The weight of the lipid determined after evaporating the solvent on a hot plate at the lowest setting.

For each sample (1m), 3.75ml1:2(V/V) CHCl3: Methanol added and well vortexed (5 minutes)and 1.25 CHCl3 and vortexed for 5 minutes with 1.25 ml distilled water and vortexed for another 5 minutes.

The resultant was centrifuged at 3000rpm with a tabletop bucket centrifuge for 15minutes at room temperature to give a 2 phase system (aqueous top and organic bottom). The bottom phase containing the lipid was recovered carefully using a micro-pipette. Weight was determined after evaporation. Percentage composition of lipid= (weight of dry flask containing sample - the weight of dry clean empty flask)/weight of sample X 100

Moisture Content Determination

The moisture content was determined by drying the sample to a constant weight, and the water content expressed as the percentage by weight of the dry sample (Deldot, 2011). Each of the samples was weighed (1g) in a crucible placed on a zeroed the weighing balance, dried in the oven for about 24 hours at 100oC and cooled in the desiccator and weighed again. The moisture content of the sample was calculated using the following equation:

%W=(A/B) X 100

Where A= weight of wet sample in grams

B=weight of dry sample in grams

Statistical Analysis

The statistical analysis was done using the mean and standard deviation formulae, and the use of charts and graphs.

Mean $(\bar{x})=\sum_0^n x/n$

Standard deviation (SD) $=\sqrt{\sum_1^n(x-\bar{x})^2}$/n-1

RESULTS AND DISSCUSSION

Carbohydrates (As Sugars) In Samples

Table 1. Standard glucose Reading

s/n	Conc.(mg/20ml)	Absorbance @540nm
1	0.500	0.3400
2	1.000	0.6859
3	1.500	1.0137
4	2.000	1.3344
5	2.500	1.5187

Values are expressed as mean

Table 2. Percentage Carbohydrates in (Substrates) Samples before and (final products) after fermentation

Corn powder	*Akamu*	Fresh milk	*Nono*
56.23 ±9.09	**7 .63 ±2.67**	**42.3 ±1.60**	**11.99 ±2.67**

Values expressed as mean± standard deviation

The noticeable fall in the percentage carbohydrate contents during the conversion of corn to Akamu and fermentation of cow milk to Nono (Table 2) mediated by many factors; for example, microbial activities are paramount in the breakdown of the carbohydrates to ethanol in the fermentation process.

Also, the addition of water during processing since carbohydrates (especially simple sugars) are primary energy metabolites, the loss in the carbohydrate content could be due to (the hydrolytic activity of the microbial enzymes into simple sugars and) the using up of the available sugars as the energy source for the growth and reproduction of the fermentation microbes. The physical cause for the loss in the percentage total carbohydrate content could be in the tradition fermentation processes that allows for increased content water to the processing substrate into the fluid state of the product. With an increased amount of water in the same substance, they will also be a percentage fall in the other nutrients (Egwim et al., 2013).

Proteins in Samples

Table 3. Standard (Egg) Albumin Reading

s/n	Conc.(mg/20ml)	Absorbance @280nm
1	1.500	0.200
2	1.250	0.213
3	1.000	0.123
4	0.500	0.070
5	0.250	0.050

Values are expressed as mean

Table 4. Percentage Proteins in Samples

***Parkia b.* seed**	***Dawada-wa***	Fresh milk	*Nono*
31.62**±0.83**	34.17**±3.6**	25.25**±0**.59	37.74**±1.8**

Values expressed as mean ± standard deviation

In Table 3 the fermentation of protein foods, there was an increase in the percentage protein in the traditional manufacture of dawadawa and Nono. This is probably due to the increased secretion of microbial enzymes such as carbohydrases, lipases, as well as the release of proteinaceous substances from the sample by fermentation and indirectly by the loss of the other food macro-nutrient during the process. The physical processes that possibly helped increase the percentage yield are in the dehulling since more proteins are rather concentrated in the seed leaves than in the hulls. This increase is agreement with the reports of Filli et al., (2010).

Percentage Lipids in Samples

Table 5. Percentage Total Lipids In Samples

Soybean powder	**Soy milk**	***Soy wara***
41±7	5.6±2.2	7.6±2

Values are expressed as mean ± standard deviation

Table 5 shows the total percentage lipids in samples. Just like in the carbohydrates, the drastic reduction of total lipids can be mainly attributed to increased addition of water during the fermentation procedure as well as increased microbial lipase action that hydrolyzed the fat thereby reducing their content.

Table 6 shows there was an increase in the moisture content with as expected Nono had the highest content as a result of increased water involved during the fermentation processes.

Thus the observed changes in the percentage nutrient (and water) content can be either of biochemical and, or physical cause and can be attributed to fermentation and its agents. All These results above follow the same trends in other literature reports for fermented food products like Cheese (Thao et al., 2017), ogi or pap (Ikese et al., 2017) Dawadawa (Adeyeye, 2011), Ugba (Pierson et al.,1986), Nono (Eka and Ohaba 1977) and Iru (Eka, 1980), Tempeh (Tahir et al., 2018) and other fermented diets (Egwim et al., 2013).

Table 6. Moisture Content (%)

Sample	***Akamu***	***Nono***	***Dawadawa***	**Soymilk**	**Soy*wara***
Substrate	9.00 ±0.00	89.0±0.58	13.0±0.87	5.0±0.00	5.0±0.0
Products	90.0±0.70	92.7±0.98	33±0.00	39±1.41	31 ±1.4

Values are expressed as mean ± standard deviation

CONCLUSION

From the results obtained, it concluded that fermented foods are relatively low in carbohydrates and lipids but high in proteins (when compared to their substrates). The high protein content may be useful in the management of diseases relating to a protein undernourishment like kwashiorkor while the reduced carbohydrate and lipid levels can help in the management of disease conditions where only little of the dietary intake of the particular nutrient is required, example diabetes and arterial sclerosis.

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