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Review article

FERMENTATION AND WEST AFRICAN FOOD CULTURE

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ABSTRACT
Food fermentation is an age-long culture that has unfortunately not been well documented, particularly in West Africa, where the absence of writing culture made its origin difficult to trace. Fermentation is mostly caused by the activity of Lactic Acid Bacteria, as well as Yeast. It principally involves the metabolism of food sugars, and conversion of lactose to lactic acid, but alcohol and carbon-dioxide can also be released. The prevalent energy crisis and poor refrigeration facilities have made the people of West African, over time, to depend largely on fermentation as the major method of preserving their food. *Ogi, Gari, Masa, Fufu, Kunu,* Palmwine, and *Iru* - all constitute and belong to the group of fermented foods in West Africa, and all have cultural peculiarities. Merits of fermentation include the improvement of food quality - chemical and sensory, food preservation, antibiotic-cum-detoxification properties, cheese coagulation, and reduction in food cost.

KEYWORDS: Food, Fermentation, Bacteria, Yeast, West Africa, Food quality, Traditional.

INTRODUCTION

Chelule *et al.* (2010) asserted that food fermentation has over the years become a part of the cultural and traditional norm among the indigenous communities in Africa. Different parts of West Africa are renowned with their own favorite food that has evolved over centuries, depending on the customs, tradition and religion. Maize gruel (*Eke* or *Akamu*) and *Garri* (pan-fried cassava grits) are two food items which among others, have traversed the sub region. These fermented food items are staple diets in Niger, Chad and Boukina Faso, Ghana, and Nigeria (Smith, 1995). The sight of *Eba and Amala* (fermented and dried cassava and yam respectively) with *egusi* soup, according to Smith (1995), being sold by road side cooked food vendors, anywhere in Ouagadougou implies that Nigerians are surely around. This underscores the importance of fermented foods. Fermentation, according to Aworh (2008) is one of the oldest and most important traditional food processing and preservation techniques. Food fermentation involves the use of microorganisms and enzymes for the production of foods with distinct quality attributes that are quite different from the original agricultural raw materials. Fermentation in food processing is the conversion of carbohydrates to alcohol, using yeast and/or bacteria, under anaerobic conditions. (Ogunshe *et al.*, 2006; Frazier and Westhoff, 2008). Raheem (2006) claimed that microbiological processing is an age long tradition in food production, but there are few documented works on these African foods. Aworh (2008) reported that the fermentation processes for many African food products constitute a vital body of indigenous knowledge used for food preservation, acquired by observations and experience, and passed on from generation to generation. Muller (1980) claimed that cereal foods are the most important substrates for fermented foods in Sub-Saharan Africa, and that fermentation will lead to production of numerous food types - alcoholic and non alcoholic. The types, flavors and peculiarities of the fermented foods are cultural attributes in West Africa. Frazier and Westhoff (2008) asserted that the interaction between microorganisms, plants and animals are natural and constant.

The Essence and Origin of Food Fermentation in West Africa

Fermentation is an age- long food culture. Battcock and Azam-Alli (1998) asserted that there is evidence of consumption of fermented foods 7000 years ago in Babylon. Odunfa (1988), however, asserted that the absence of writing culture in West Africa during the medieval ages makes the origin of fermentation difficult to trace. Ibn Batuta reported around 1392 that the people of *Walata* in Sudan do consume porridge made of millet and sour milk (similar to Nigerian *Fura)*. Mansa Sulaiman, the Malian king, served Ibn Batuta with a gourd filled with Sour Milk. The governor of Walata was similarly reported to serve important dignitaries with *Dakno*, a beverage containing sour Milk and Honey (Odunfa, 1988). Most West African communities are renowned for different fermented foods, including;

OGI

The traditional *Ogi* preparation (*Koko* in Ghana) involves steeping maize, millet or sorghum in water for 1-2 days, followed by wet-milling, wet-sieving and fermentation for 2-3 days. The major microorganisms associated with the fermentation of ogi are lactic acid bacteria and yeasts (Aworh, 2008) *Ogi, Koko, Akamu* and similar products

from locally available cereals remain the most important infant food and complementary food in West African countries (Egwim *et al.*, 2013). *Ogi* is commonly made of maize and sometimes guinea corn (*Ogi baba* - yoruba). *Akamu* is the northern Nigerian variant, made mostly from guinea corn and/or millet. The Solid preparation of *Ogi* is *Kenkey* in Ghana, *Mawe* in Benin Republic, and *Agidi* in Western Nigeria.

GARI

Gari is the granular flakes that are obtained from peeling, washing, grating, and fermenting cassava tuber. This resultant pulp is pulverized, sieved and toasted to dryness. The processing is labour intensive. Cassava is native to South America but was introduced to West Africa in the late 16th century where it is now an important staple in Nigeria, Ghana, Ivory Coast, Sierra Leone, Liberia, Guinea, Senegal and Cameroon. Jeon and Halos (1991) reported that about 413 man hours are required to process a ton per ha yield of cassava to *Gari*. The dewatering, toasting, and occasional addition of palm oil reduces the Cyanide toxicity to minimal level. The resultant flakes can be soaked and drank as afternoon beverage, or soaked in hot water to make "*Eba*" a solid meal.

TABLE 1: Some Traditional Nigerian Fermented Foods and Fermenting Micro-organisms

Fermented Food	Raw Material (Substrate)	Micro-organisms Involved
Gari	Cassava pulp	*Leuconostoc spp.* *Lactobacillus spp.* *Streptococcus spp.*
Fufu	Whole cassava roots	*Geotrichum candidum* *Lactobacillus spp.* *Leuconostoc spp.*
Lafun	Cassava chips	*Leuconostoc spp.* *Lactobacillus spp.* *Corynebacterium spp.*
Ogi	Maize, sorghum, millet	*Candida tropicalis* *Lactobacillus plantarum* *Streptococcus lactis* *Saccharomyces cerevisiae* *Rodotorula spp.*
Iru (Dawadawa)	African locust bean (*Parkia biglobosa*) / soybean	*Candida mycoderma* *Debaryomyces hansenii* *Bacillus subtilis* *B. licheniformis*
Palm wine	Palm sap	*Saccharomyces spp.* *Lactic acid bacteria* *Acetic acid bacteria*
Burukutu/Pito/Otika	Sorghum, Millet & Maize	Saccharomyces spp. Lactic acid bacteria

Sources: Raheem (2006) and Aworh (2008)

MASA

Described by Egwim *et al.* (2013) as a fermented puff batter, made from rice, millet, maize or sorghum, that is traditionally cooked in a pan with individual cup-like depressions. It is similar to the Indian *Idli* in shape and the *Dosa* in taste. It is a staple in Northern Nigeria and Boukina Faso, Niger and Chad. The southern Nigeria *Masa* is fried directly in Vegetable oil.

FUFU

Fufu is the fine paste obtained after peeling, slicing, soaking, fermenting, grading and cooking of whole cassava roots. Uyoh *et al.* (2009) claimed that the lactic acid fermentation during soaking reduces the pH, softens the tubers, and reduces the cyanide toxicity. The soft pulp is pulverized by hand, sieved, and the fine starchy sediment can be cooked into a thick paste called *fufu.*

IRU

Iru or Dadawa, made from washing, boiling and fermenting the African locust bean seeds, (*Parkia biglobosa)*, according to Odebunmi *et al*. (2010) and Onyenekwe *et al*., (2012) is the most important natural food condiment for flavoring soups and stews in Nigeria. Traditionally, the locust bean seeds are first boiled and tenderized for 15 hours, then dehulled by sand abrasion, by gentle pounding or by trampling under foot, then boiled for 30 minutes to 2 hours, then molded into small balls and wrapped in leaves of paw-paw or banana (Aworh, 2008).

PALM WINE

It is an alcoholic beverage created from the fermented sap of various palm trees. It can be collected (or tapped) from the oil palm tree - *Elaies guineensis* or from the Raffia tree - *Raphia* sp. which is shorter and thus more accessible. Fermentation begins immediately after collection, as a result of activity of natural yeasts in the air, acting on the sugars. Within two hours, the alcohol content reaches approximately 4%. At this stage, the product is a sweet, white, mildly intoxicating aromatic beverage. Continued fermentation for up to 24 hours results in a more alcoholic, acidic, and sour white drink (Mbuagbaw and Noorduyn, 2011)

FURA

This is wet milled and fermented millet paste. Aduku and Olukosi (2000) described it as cooked millet dough.

KUNU

This is a refreshing maize/millet beverage. The fermented paste is almost fully cooked in boiling water.

NONO

Thin Yoghurt, *Nono* is naturally fermented milk. Aduku and Olukosi (2000) described it as dense, undiluted sour milk, to which Baobab fruit flour can be added as a stabilizer or thickener. *Nono* is often drunk with *Fura*, and is referred to as *Fura de Nono.*

KINDRIMO

Thick yoghurt, it is naturally coagulated cheese that is drunk as yoghurt. The coagulation is by self fermentation.

BURUKUTU

Burukutu is an alcoholic beverage obtained from fermentation and malting of Sorghum and/or Millet Grains. *Shekete, Pito* and *Otika* are similarly obtained from fermentation of other cereals/cereal combinations.

PITO

It is widely consumed in Ghana and Southern Nigeria. It contains 3% alcohol (Egwim *et al.*, 2013)

TABLE 2: Nutritive Value of Commonly Fermented Cereals (per 100g of edible portion)

Foods	Energy (Kcal)	Protein (g)	Thiamine (mg)	Niacin (mg)	Calcium (mg)	Iron (mg)
Millet	341	10.4	0.3	1.7	22.0	20.7
Sorghum	340	9.4	0.25	3.7	45.0	8.8
Maize	357	9.4	0.33	2.2	16.6	3.6

Source: Smith (1995)

TABLE 3: Nutritive Value of Commonly Fermented Staples (per 100g of edible portion)

Foods	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Iron (g)
Yam	119	27.8	1.9	0.8
Cassava	149	32.4	1.2	1.9
Gari	351	84.2	1.0	1.6

Source: Smith (1995)

The Food Fermentation Process

The essence of fermentation is the splitting of glucose molecule into two pyruvate molecules (Wikipedia, 2011), and can be achieved by Lactic Acid Bacteria through any of the two pathways viz -

a) ***Homolactic acid fermentation***

During the production of *Gari* for example, lactate is the major product of fermentation.

$C_6H_{12}O_6 \rightarrow 2\ CH_3CHOHCOOH$

b) Heterolactic acid fermentation

An example is production of *Burukutu*, where one pyruvate molecule is converted to lactate; while the other, to ethanol and carbon dioxide as illustrated below.

$C_6H_{12}O_6 \rightarrow CH_3CHOHCOOH + C_2H_5OH + CO_2$

Merits of Food Fermentation

Jimoh *et al.* (2012) reported that fermentation adds to the nutritive value of food, enhances its flavours, improves its digestibility and edibility, yet improves its industrial utility. Oyewole and Isah (2012) outlined food detoxification, preservative quality, improved marketability, decreased cooking time, and numerous health benefits that can be derived from food fermentation.

Improvement in Nutritional Quality

Food fermentation process allows many enzymes, including lipases, amylases, phytases and proteases to come in contact with, and hydrolyze, or modify complex food substances.(Adeyemi and Muhammed, 2008). Fermentation, according to Aworh (1993), Santos (2008), as well as Soetan and Oyewole (2009), increases the digestibility of proteins, increases minerals bio-availability by hydrolysis of complexing agents, and increases B-vitamins levels, through microbial synthesis.

Preservative and Antibiotic properties

Fermentation basically acts as a barrier against non-acid tolerant bacteria that becomes ecologically eliminated from the food medium (Agarry *et al*., 2010). Fermentation lowers the pH to about 4 through acid production, thereby inhibiting the growth of pathogenic, spoilage-causing organisms, minimizing food poisoning and disease, and by doing this, prolonging the shelf life of fermented food (Abdel and Dardir, 2009; Olukoya *et al.*, 2011). The production of Hydrogen Peroxide, Bacteriocins and other Inhibitory substance, has been documented (Olanrewaju *et al.*, 2009). Benefits including antimicrobial, immune-modulatory, antiallergenic, antihypertensive and antitumourigenic effects are equally reported (Osuntoki, 2010). The use of LAB fermentation to deter pathogenic enteric bacteria is by intestinal modification of microorganisms and thus fermentation prevents diarrheal diseases (Olukoya *et al.*, 2011).

Cheese Coagulation

The use of fermented maize supernatant, (which would otherwise be decanted as waste liquid in *ogi* production) as a coagulant in cheese production is a significant step in food security. Omotosho *et al.* (2011), and Badmos and Joseph (2012) have described the potency of fermented Maize supernatant(steep) as an ingredient for West African soft cheese production.

Food Detoxification

Ari *et al.* (2012) claimed that Fermentation destroys microtoxins like fumonsins, aflatoxin, ocratoxin A, without food degradation or unpleasant residues. The detoxification of cassava tubers, with high cyanide content is a very significant benefit of fermentation. Processing cassava roots into *Gari* is the most effective traditional means of reducing cyanide content of cassava to a safe level by WHO standards of 10 ppm, and is indeed more effective means of detoxification than heap fermentation and sun drying, commonly practised in southern and eastern Africa (FAO 1991; Cardoso *et al.*, 2005).

Enhancement of Organoleptic Properties

Aworh (2008) reported that fermentation improves the texture and flavor of foods, imparting pleasant sour taste to fermented foods, like *Gari* and *Ogi*, and giving distinct flavor components peculiar to many fermented foods. The peculiar organoleptic properties make fermented foods more preferable to the typical Nigerian consumer. (Osungbaro, 2009).

Socio-economic Merit

The contribution of fermentation to food availability has been emphasized by Aworh (2008) and Chelule *et al.* (2009). Employment Generation of the food fermentation industry is enormous, considering the number of people involved in Processing and sale of *Garri, Fufu, Ogi* and other foodstuffs. Essien *et al.* (2011) reported that the production and Marketing of *Kunu,* the fermented millet beverage has become a part of Nigerian communal life, and poverty alleviation strategy.Fermentation, by changing the nature and property of food materials, have in addition reduced the use and cost of fuel for cooking foodstuffs (Oyewole and Isah, 2013; Egwim *et al.*, 2013).

CONCLUSION

Food Fermentation in West Africa is a traditional technology, and has a peculiar cultural value, as many of the fermented foods have come to be associated with West African communities. Fermentation improves the value of the food materials giving it higher quality, better preservation and detoxification. Fermentation also increases the consumer preference of foods. There is need for deeper studies and technological improvement of traditional fermentation practices to make fermented foods meet international standards, and increase its preservative quality and marketability.

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