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. Batcock 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**

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

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 Olukoshi (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.

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

<table>
<thead>
<tr>
<th>Foods</th>
<th>Energy (Kcal)</th>
<th>Protein (g)</th>
<th>Thiamine (mg)</th>
<th>Niacin (mg)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet</td>
<td>341</td>
<td>10.4</td>
<td>0.3</td>
<td>1.7</td>
<td>22.0</td>
<td>20.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>340</td>
<td>9.4</td>
<td>0.25</td>
<td>3.7</td>
<td>45.0</td>
<td>8.8</td>
</tr>
<tr>
<td>Maize</td>
<td>357</td>
<td>9.4</td>
<td>0.33</td>
<td>2.2</td>
<td>16.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Source: Smith (1995)

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

<table>
<thead>
<tr>
<th>Foods</th>
<th>Energy (Kcal)</th>
<th>Carbohydrate (g)</th>
<th>Protein (g)</th>
<th>Iron (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yam</td>
<td>119</td>
<td>27.8</td>
<td>1.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Cassava</td>
<td>149</td>
<td>32.4</td>
<td>1.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Gari</td>
<td>351</td>
<td>84.2</td>
<td>1.0</td>
<td>1.6</td>
</tr>
</tbody>
</table>

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\(_6\)H\(_{12}\)O\(_6\) → 2 CH\(_3\)CHOHCOOH

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\(_6\)H\(_{12}\)O\(_6\) → CH\(_3\)CHOHCOOH + C\(_2\)H\(_5\)OH + 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. Oywolale 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 substances, has been documented (Olasoji et al., 2009). Benefits including antimicrobial, immune-modulatory, antioxidant, 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 diarrhoeal diseases (Olukoya et al., 2011).

Cheese Coagulation
The use of fermented maize supernatant, (which would otherwise be decanted as waste liquid in oyi 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 fumonisins, aflatoxin, ochratoxin 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 heat 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 Garri 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. (Osunghoro, 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 (Oywelle 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.

REFERENCES


