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Review

Enhancing sustainable development through indigenous fermented food products in Nigeria

A. T. Adesulu[1]* and K. O. Awojobi[2]

[1]Department of Microbiology, University of Ibadan, Oyo State, Nigeria.
[2]Department of Microbiology, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

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Indigenous fermented food products are mainly produced by the activities of microorganisms and their preparation remains today as a household art. Fermented food products play very important roles especially in the socio-economic aspect of people in developing countries. In Nigeria, there are large variety of fermented foods and beverages with traditional and cultural value, these fermented food products includes 'Ogi', 'Gari', 'Fufu', 'burukutu', 'Pito', 'Iru', 'Ogiri' etc. The fermentation in its production involved various biochemical processes and different lactic acid fermentation. Indigenous fermented food products enhances sustainable development in Nigeria through provision of employment opportunities, thus improving the livelihoods of the citizenry, poverty alleviation, empowerment initiatives, market improvement using simple, low-cost, traditional food processing techniques andenhanced food security providing regular income for the producers. Fermentation of indigenous fermented food also improves its organoleptic and preservative properties, adding to their nutritional quality. This paper outlines common indigenous fermented food products in Nigeria, microorganisms involved during the fermentation processes, their health benefits, emphasizing their sustainability towards National development and also the microbiological and biochemical changes during the fermentation processes.

Key words: Indigenous, socio-economic, food security, national development.

INTRODUCTION

Fermented foods are defined as those foods which have been subjected to the action of micro-organisms or enzymes so that desirable biochemical changes cause significant modification to the food (Campbell-Platt, 1987). They are described as palatable and wholesome and are generally appreciated for attributes, their pleasant flavors, aromas, textures, and improved cooking and processing properties (Holzapfel, 2002).Fermented foods are produced in our homes, villages and also in small-scale food industries. Varieties of fermented foods are produced in developing countries, using traditional fermentation technology at the household level. The preparation of many indigenous fermented foods and beverages today remains a household-art. Traditional

*Corresponding author. E-mail: adesuluchemmy@yahoo.com. Tel: +2348154796861.

fermentation processes are typically uncontrolled and dependent on micro-organisms from the environment. Since the beginning of human civilization there has been an intimate relationship between man, his fare, and the fermentative activities of microorganisms. Traditional fermentation process is the most available and affordable food preservation method, which is of great economic importance to developing countries. Foods derived from fermentation are major constituents of the human diet all over the world (FAO/WHO, 1996). In some regions, mainly in African countries, fermentation plays important role in the nutrition of infants and young children as it is used for the preparation of complementary foods (Yasmine, 2000). Fermentation provides an economic means of preserving food and inhibiting the growth of pathogenic bacteria even under conditions where refrigeration or other means of safe storage are not available. It also enhances the nutritional quality of certain foods. In many parts of the world, particularly in Asia and in Africa, the technology has been traditionally used asa preservation method to ensure food safety (Yasmine, 2000). It preserves and enriches food, improves digestibility, enhances the taste and flavor of foods and is also easily accessible to all populace for its consumption. Fermentation also has the potential of enhancing food safety by controlling the growth and multiplication of a number of pathogens in foods (FAO, 2008). Thus, it makes an important contribution to human nutrition, particularly in developing countries, where economic problems pose a major barrier to ensuring food safety. The microorganisms responsible for the fermentation may be the microflora indigenously present on the substrate, or they may be added as starter cultures.

This paper aims to provide a review on the common indigenous fermented foods consumed in Nigeria, its sustainability towards national development and the microorganisms involved during the fermentation processes. As well as its health benefits of these food are summarized.

PROCESSES INVOLVED DURING FOOD FERMENTATION

Fermentation is a form of energy-yielding microbial metabolism in which an organic substrate, usually a carbohydrate, is incompletely oxidized, and an organic carbohydrate acts as the electron acceptor (Adams, 1990). The mechanism of food fermentation is essentially the conversion of carbohydrates to alcohols and carbon dioxide or organic acids by yeasts, bacteria, or a combination thereof, under anaerobic conditions. Lactic acid bacteria (LAB) are commonly involved in the fermentation of carbohydrate based substrates (Beukes et al., 2001). The two processes that are involved during the indigenous food fermentation are; Lactic acid fermentation (homolactic acid fermentation) and alcohol fermentation (heterolactic acid fermentation).

In fermentation, the substrate is only partially oxidized, ATP is formed exclusively by substrate-level phosphorylation, and oxygen is not needed. Lactic acid fermentation at the household level is a natural process brought about by lactic acid bacteria present in the raw food (WHO, 1989). In lactic acid fermented foods, the acidity is usually below pH 4. Most pathogenic microorganisms found in food cannot survive this low pH, hence, lactic acid fermentation of food has been found to reduce the risk of having pathogenic microorganisms growing in food (Sahlin, 1999).

COMMON INDIGENOUS FERMENTED FOODS IN NIGERIA

Fermented foods contribute to about one-third of the diet worldwide (Campbell-Platt, 1987). They are described as palatable and wholesome and are generally appreciated for attributes: their pleasant flavors, aromas, textures, and improved cooking and processing properties (Holzapfel, 2002). Indigenous fermented foods have been prepared and consumed for thousands of years, and are strongly linked to culture and tradition (Sekar and Mariappan, 2005). They are processed through the activities of microorganisms. Indigenous food fermentation is one of the oldest biotechnology process in which microorganisms play an essential role in production and preservation. Many Indigenous fermented foods produced in Nigeria are fermented before consumption. The fermented foods in Nigeria can be classified into groups according to the substrates or raw materials employed (Odunfa, 1985). These includes; ogi, ogi baba, masa, pito, burukutu (fermented products from maize, sorghum or millet), gari, lafun, fufu (fermented products from cassava), iru, dawadawa (fermented products from African locust beans and soya beans), ogiri (a fermented product from melon seeds), nono (fermented stimmed cow milk/wara-kishi), ugba (fermented oil bean), kunu zarki (fermented millet), palm wine. These fermented foods are produced and processed using natural fermentation method.

MICROORGANISMS INVOLVED DURING THE FERMENTATION PROCESSES

The indigenous natural fermentation takes place in a mixed colony of microorganisms such as moulds, bacteria and yeasts (William and Dennis, 2011). The microorganisms involved in African food fermentation are restricted to a few groups of yeasts and bacteria (Odunfa, 1985). Microorganisms that are associated with the fermentation of different traditional fermented food products of Nigeria have being extensively studied by various researchers. The most common organisms responsible

for fermentation of foods are acid-forming bacteria such as genera lactic acid bacteria (LAB) which includes *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Lactococcus*, *Streptococcus, Aerococcus*, *Corynebacterium*, *Enterococcus* and *Oenococcusn*. Lactic acid bacteria that are important in food technology include those of the genera *Lactobacillus, Lactococcus,Pediococcus,* and *Leuconostoc* (Harrigan and McCance, 1990). Some yeast such as *Saccharomyces* and moulds such as *Penicillium, Aspergillus* and *Botrytis*are also involved during the fermentation process due to thelactic acidthey produce (Wood and Holzapfel, 1995). Lactic acid bacteria (LAB) play a key role in safety and acceptability of fermented foods. Sanni and Adesulu (2013) reported reduction in pH during the fermentation of the maize meal for masa production and it was inferred that most bacteria including the pathogenic organisms do not survive in low pH environment and this imparts microbial safety as well as acceptability of the fermented food. Lactic acid bacteria are the most important group of microorganisms involved in the spontaneous or natural fermentation of foods (Steinkraus, 2002; Jakobsen and Lei, 2004). They are Gram positive, non-spore forming, catalase negative cocci or rods that are anaerobic, micro-aerophilic or aerotolerant (Wood and Holzapfel, 1995). Moulds are also involved during the food processing. Nearly all food fermentations are the result of more than one microorganism, either working together or in a sequence, but growth is generally initiated by bacteria, followed by yeasts and then moulds (FAO, 1998). Compounds formed during fermentation processes includes; organic acids (palmitic, pyruvic, lactic, acetic, propionic, malic, succinic, formic and butyric acids), alcohols (mainly ethanol) aldehydes and Ketones (acetaldehyde, acetoin, 2-methyl butanol) (Ari et al., 2012).

IMPROVEMENT ON FERMENTED FOODS IN NIGERIA

Fermented foods are treasured as major dietary constituents in numerous developing countries because of their keeping quality, undue ambient conditions enhancing nutritional quality and digestibility, improve food safety, and are traditionally acceptable and accessible (Holzapfel, 2002, Rolle and Satin, 2002).Indigenous fermented products, according to the mechanism that occur during the fermentation helps to promote safety of foods. However, the final product can be risky resulting from the poor hygienic conditions during processing. Optimization of the fermentation process will result in production of quality, safe and acceptable fermented foods and these can be carried out by: Application of appropriate starter culture, back-slopping, raw material development, enhancement of fermentation processes, application of HACCP system and Good Manufacturing Practice, development of better equipment and development of standard for commercialization.

HEALTH BENEFITS OF INDIGENOUS FERMENTED FOODS

A number of foods especially cereals are poor in nutriational value, which constitute the main staple diet of the low income populations (Chelule et al., 2010). However, Lactic Acid Bacteria fermentation has been shown to improve the nutritional value and digestibility of these foods (Nout, 2009). The enzymes including amylases, proteases, phytases and lipases, modify the primary food products through hydrolysis of polysaccharides, proteins, phytates and lipids respectively (Adeyemi and Muhammad, 2008). The quantity and quality of the food proteins as expressed by biological value, and often the content of water soluble vitamins is generally increased, while the antinutrient factors (ANFs) such as phytic acid and tannins in food decline during fermentation leading to increased bioavailability of minerals such as calcium, phosphorus, zinc, iron, amino acids and simple sugars (Santos et al., 2008; Soetan and Oyewole, 2009; Murwan and Ali, 2011). Some of the microorganisms involved in traditional fermentations present beneficial effects in human health; they cause reduction of toxin in food, with the binding of aflatoxins by yeast of the genus *Saccaharomyces*. Lactic acid bacteria in fermentation detoxified toxins and are more advantageous, in that it is a milder method which preserves the nutritive value and flavor of foods (Chelule et al., 2010). Fermentation ire-versibly degrades mycotoxins without adversely affecting the nutritional value of the food (Ari et al., 2012).

Many of the fermented products consumed by different ethnic groups have therapeutic values, some of the most widely known are fermented milks (that is, yoghurt, curds) which contain high concentrations of probiotic bacteria that can lower the cholesterol level (Jyoti, 2010), Improvement of nutrients absorption and digestion, restores the balance of bacteria in the gut to hinder constipation, abdominal cramps, asthma, allergies, lactose and gluten intolerance (Abdel et al., 2009). The slurries of carbohydrate based fermented Nigerian foods such as ogi, fufu and wara have been known to exhibit health promoting properties such as control of gastroenteritis in animals and human (Aderiye et al., 2007; Olukoya et al., 2011). Some microorganisms involved during the fermentation also produces antimicrobial products that lead to safe and long storing of foods (Steinkraus, 2002).

ENHANCING SUSTAINABILITY OF INDIGENOUS FERMENTED FOOD PRODUCTS IN NIGERIA

Fermented food products can play an important role contributing to the livelihoods of rural and periurban dwellers alike, through enhanced food security, and income generation via a valuable small scale enterprise option (FAO, 2011). Fermentation activities plays significant role towards contributing to the livelihoods of women, the disabled and

landless poor who, with appropriate training and access to inputs, can increase their independence and self-esteem through income generation (FAO, 1998). Fermented food products play an important socio-economic role in Nigeria. In enhancing sustainability of indigenous fermented food products in Nigeria, there is a need to overcome constraints that may cause set back in the socio-economic status of the populace and stipulating standards that will help every citizenry to alleviate poverty and other vices that may pose threat to the National economy. Sustainable development is enhanced with these suitable approaches;

Eradication of food shortage

Fermented foods constitute a major portion of peoples' diets all over the world and make a major contribution to dietary staples in numerous countries across Africa, and the world at large, providing 20 - 40% of the total food supply (Abdel et al., 2009). Small-scale fermentation technologies contribute substantially to food security and nutrition, particularly in regions that are vulnerable to food shortages (FAO, 1998), this thus contributes to sustainable development of the country as little is spent on imported foods.

Food security

Fermentation as a means of food preservation and preparation has the potential of meeting the Nigerian's food supply demand if it is mechanized and industrialized. This is achieved through improved food preservation method, increasing the range of raw materials that can be used to produce edible food products in large quantity and removing anti-nutritional factors to make food safe to eat. Indigenous fermented foods promote and improve food processing and preservation at all levels of operation, which are essential component of national strategic plans for food security aim at achieving national food security (Adeyemi and Muhammad, 2008).

Employment benefits

Fermentation enterprises are employers of many millions of people in the world (Elaine and Danilo, 2011). They are considered to be industrial set ups process, prepare, package, market and in some cases brand products and employ many thousands of people (FA0, 2011). Majority of employment comes from small scale fermentation enterprises. Traditional and small-scale fermentation enterprises have a good employment record, especially in remote areas, even where access to sophisticated equipment is limited. As a result of increased and continual popularity of fermented products', such small-scale enterprises potentially have the capacity of generating even more widespread employment options (FAO, 2011). By generating employment opportunities in the rural areas, small scale food industries reduce rural-urban migration and the associated social problems (Aworh, 2008). In Japan and Latin America, fermented food forms important sectors of their economy, where more than 560 000 tonnes of *miso* (fermented legume product) is produced yearly to form fermented cereal products, alcoholic drinks, and fermented milk products (FAO, 1998), fermentation of foods thereby provides global importance of employment.

Youth empowerment initiatives

Youths in developing nations are the sect of people who have great strength and potentials in them and if they are adequately empowered they will produce their best and indirectly providing employment benefits to the unemployed youths, this will greatly increase and promote sustainable growth. They will also find ready employment on their door step and will have the opportunity to increase their knowledge in fermentation practices, thus becoming competent and skilled in a profession. Organizations can also help with training, capacity building and improving fermentation techniques, thereby empowering them. Moreover if subject to training in fermentation processes, process management, quality control and business matters, their capacity will increase as new knowledge will be gained and will have more transferable skills than the crude methods employed so far.

Reduction in mortality rate

Fermentation prevents the enlargement of pancreas. Since fermented foods are rich in enzymes, there is high reduction in mortality rate. "Eating an enzyme-rich diet decreases the load on pancreas, preserving the body's own natural enzyme potential, thereby reducing the risk of chronic diseases". Eat more raw food, fermented food and living food (Kristen, 2011).

Industrialization

Indigenous fermented foods production provides opportunities for generation of income through employment and thereby promoting industrial development in Nigeria. Small-scale food industries that involve lower capital investment and that rely on traditional food processing technologies are crucial to rural development in Nigeria (Aworh, 2008). Industrialization brings about economic development of any nation; this will have concerted effect on the sustenance of average citizenry of the nation.

Poverty alleviation

Poverty alleviation scheme set up by governments and agric banks in form of loans and credits has helped to

alleviate poverty to a very low level among the populace and has provided a source of income, it also contributes to the food security of the nation. Government setting up resource workers to organize programmes and enlightening the farmers on the potential opportunities of earning income from providing certain fermented products, this will enable better production planning, less waste, reduction in costs and potentially making only products that have a good demand and thus increasing the likelihood of selling and earning income. Moreover by meeting with customers regularly can help develop a farmer's local sales network playing a beneficial role in poverty alleviation and economical development of the nation.

Market improvement

The general level of market development in areas where fermented goods are promoted is an important factor determining their market potential. Good understanding of the fermentation process usually based on traditional knowledge but may also be acquired or improved through external support from governments and research institutes thus allow producers to provide consistent and predictable quantities and qualities of fermented products, thereby attracting buyers more easily. Fermentation activities undertaken represent an important economic opportunity, earnings made can provide for family needs and savings.

Food supplement

The locally fermented foods serve as food supplement like the use of ogi as a weaning food in Southern Nigeria to supplement breastfeeding (Falana et al., 2011). The fermented foods made available the diet required in human body (Egbere, 2008). Traditional fermented protein-rich foods offer excellent opportunities for improving the diets of people in tropical countries providing rich source of starch, vitamins, proteins and minerals (Oladejo and Adetunji, 2012).

Food availability

They are vital to reducing post-harvest food losses and increasing food availability (Aworh, 2008). Fermented foods are of great significant because they provide and preserve vast quantities of nutritious foods in a wide diversity of flavours, aromas and textures which enrich the human diet (Yabaya, 2008).

CONCLUSION

Several indigenous fermented food products are processed in Nigeria. The fermentation technology practices by the traditional people shows a strong correlation of these people with nature and the assessment of microbial benefits. The rich microbial diversity in various sources of fermented foods reflects that the indigenous people have been harnessing indigenous microbiota for spontaneous fermentation. Fermentation technology practices contribute to subsistence of regional economy and prove as a boost to the livelihood of the rural people. These traditional methods of fermentation and preservation can be commercialized and productivity can be maximized if contributions in terms of support are provided by various governing bodies and institutes. As an appropriate food preservation technology, the economic and social benefit of applying small-scale fermentation in food preservation contributes to sustainable development. Fermentation however, requires very little sophisticated equipment, either to undertake or subsequently store the fermented product, and has had a major impact on nutritional habits, traditions, and culture. The development of appropriate approaches aimed at enhancing the quality of indigenous Nigeria foods will be indispensable for the growth and survival of the food industry.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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