Chapter 4
Significance of African Fermented Foods in Nutrition and Food Science

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4.1 Introduction

Food fermentation is a kind of food preservation technology that is practiced traditionally in the past in many African countries and still being used by indigenous people and most communities of the developing countries. It is performed by the fermenting action of micro-organisms especially yeast fungus and bacteria of lactic acid (Mokoena et al. 2016). In developing countries, fermented food and beaverages are considered one of the main dietary stuffs that are consumed due to their preferred taste, quality and food digestibility (Nout and Motarjemi 1997). There are various strategies for fementing food practiced by Africans including alcoholic, non-alcoholic, alkaline and amino acid fermentation based on plants, milk, insects and meat (Dirar 1993; Oyewole 1997; Steinkraus 1997). However, fermentation of plant and animal-based foods differ in the contents of their end products. Plant-based food products are rich in their contents carbohydrates and sugars which are essential substrates for completing microbial fermentation process, while animal-based food products have their characteristic of less carbohydrates and more protein content (Kewuyemi et al. 2020). The present chapter explains the significance of African fermented foods focusing on some important types of food as traditionally and commonly used in different parts of Africa and their beneficial effect in food science. Figure 4.1 shows the most important African fermented food sources.

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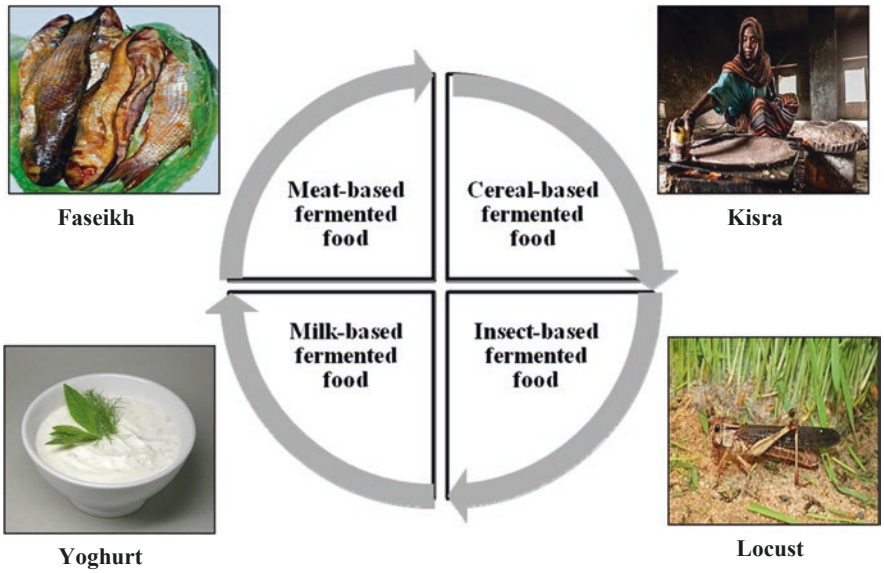

Fig. 4.1 The most important fermented foods in Africa

4.2 Cereal-Based Fermented Foods

In Africa, Cereals like oat, barley, corn and sorghum/millet are considered as primary human food stuff due to their high nutritive contents for children and adults (Achi and Ukwuru 2015). Additionally, adout 70% of the total energy intake depends on cereals in developing countries (Descalzo et al. 2018). Cereals are very good substrates for fermentation achieved by therapid growth of probiotic bacteria and micro-organisms (Kedia et al. 2007; Kocková et al. 2011). Additionally, ceral-based fermented foods from millet (*Peninsetumamericanum*), maize (*Zeamaize*) and sorghum (*Sorghum bicolor*) is traditionally and widely practiced for preserving food and improving the organoleptic properties of food by the action of lactic acid bacteria. Further, fermentation of cereals removes mycotoxins, reduces anti-nutrional factors and improves nutrional profiles of the produced food (Achi and Ukwuru 2015). Nutritionist reported that bacterial fermentation of cereals reduced the percentage of aflatoxins in African cereal-based beaverages 1000 folds (Wacoo et al. 2019). Fermentation of cereals positively elevates health-promoting biologically active compounds such as polyphenols through the break down of cereal's cell wall and the release of active polyphenols increasing their antioxidant acivity that protects against many ailments (Adebo and Gabriela Medina-Meza 2020). Morover, the probiotic activity of micro-organisms during fermentation of food modulates gut microbiota and improves the immune response of the body reducing the risk of occurrence of hypertension, hypercholesterolemia, inflammatory bowl disease, diabetes and cancer (Chileshe et al. 2020).

4.2.1 Sorghum and Millet

Sorghum and millet-based fermented foods such as *kisra*, *hulu-mur*, *merica* and *nasha* are very common in many African countries especially in Sudan, Nigeria and Tanzania as main food products for indigenous people (Adebo 2020). Sorghum contains highly nutritive components such as proteins, polysaccharides, vitamin B, iron and high fiber contents. Also it contains biologically active compounds such as anthocyanines and polyphenols of high antioxidant activity (Adebo 2020). As mentioned in the previous section, microbial fermentation of sorghum leads to cell wall rupturing of sorghum grains and releasing high percentage of the phytochemical constituents especially phenolic compounds that play key role as anti-cancer, gastrointestinal health potential, anti-dibetic andcardioprotectivecandidates (Taylor and Duodu 2015).

4.2.2 Maize

Nutrtionists reported that maize contains valuable nutrients of carbohydrates, proteins, fats, vitamins as vitamins B and C, minerals as manganese and phosphorus in addition to folate and fiber. In addition, maize is rich in phytochemical compounds *viz*phenols, carotenoids and polysterols (Saeed and Saeed 2020). Based on a recent study on the effect of fermentation on the nutritional and the phytochemical composition of maize, it was found that maize *Lactobacillus* fermentation of maize increased its constituents of vitamins B, C and E, folate, riboflavin and carotenoids compared to unfermented samples (Chaves-López et al. 2020). Additionally, fermentation increased the soluble phenolic compounds content of maize (Gabaza et al. 2018). In a study, Scientists found that the famous maize-based African fermented foods, *Ogi* and *Omidun*could significantly protect the rats from experimentally-induced colitis *via*prevetion of depletion of colonic antioxidant enzymes (Haruna et al. 2019). The maize-based non-alcoholic fermented beverage, *Munkoyo* from Zambia was found to have anti-microbial and anti-allergic activities, and suppresses diarrhea (Chileshe et al. 2020).

4.2.3 Barley

Barley is another important African cereal regards its nutrional value and biochemical composition. It is significantly rich in the dietary fiber, β-glucan and contains relative percentage of phosphorous and potassium minerals. In addition, it contains healthy unsaturated fatty acids and bioactive phenolic compounds that play key role in protecting against diseases (Lahouar et al. 2017). Fermentation of barley seeds with *Lactobacillusplantarum* was recently found to reduce obesity in rats induced

by high-fat diet and type-2 diabetes (Gu et al. 2021). In another clinical study, fermented barley diet reported considerable improvement in the complications resulted from metabolic syndrome through improvement of insulin sensitivity, plasma level of lipids and significant decline in the blood glucose level (Pan et al. 2020). The South African barley-based fermented food *Boza* showed increased contents of vitamins, minerals and fibers due to the fermenting action of *Lactobacillusplantarum* and reported improvement in the gastrointestinal health in addition to lowering cholesterol level in the blood and stimulating the immune response of the body (Ignat et al. 2020).

4.3 Insect-Based Fermented Foods

Indigenous Africans started practicing insect-based fermented food products as one of the strategies as food security in the African continent. At the nutritional level, edible insects are considered better sorce of proteins up to more than 70%, fats >50% and energy >600 kcal (Kewuyemi et al. 2020). Based on entomophagy study (Kelemu et al. 2015), there are more than 450 edible insect species are limited to different regins of Africa such as the caterpillar *Cirinaforda*, termites (*Macrotermes*spp.), crickets (*Gryllus*spp.), the grasshopper *Raspoliadifferens,* the locust *Normadacrisseptemfasciata,* beetles (*Orystes*spp.) and bees (*Apes* spp.) (Kewuyemi et al. 2020). Indigenous Africans practiced fermentation strategies of edible insects to suppress the growth of pathogenic micro-organisms as per the reports of different studies (Klunder et al. 2012). As mentioned earlie in the introduction section of this chapter, edible insects are poor in carbohydrate content and rich in protein content which is susceptible for microbial actions. Unlike plant-based foods, edible insects require pre-treatment strategies before fermentation process such as salting, smoking, boiling and drying. These pre-processes are important to remove the exoskeleton of insects and expose the vital nutrients required for the action of micro-organisms during fermentation (Borremans et al. 2018). Researchers focused on insect-based fermented food products for their nutritive characteristics. The sauces produced from the grasshopper *Locustamigratoria*was found to have very good flavour due to their high glutamate and aspartate content (Mouritsen et al. 2017). The fermented powder produced from mulberry silkworm larvae *Bombyxmori*showed high fatty acid content and *in vitro* anti-cancer activity in human liver cell line (Cho et al. 2019). The fermented paste prepared from the yellow mealworm larvae *Tenebriomolitor*reported anti-bacterial activity (Borremans et al. 2018).

4.4 Milk-Based Fermented Foods

Historically, milk and diary productssuch as youghurt, cheeses and fermented products are well known in the diets urban and rural countires of the African continent for their cheapest product and crucial role in the growth of infants as well as adults' requirements of essential nutrients (Dirar 1993; Owusu-Kwarteng et al. 2020). Ordinarily, milk and diary products are rich in their nutrional value as they contain high concentration of vitamins, minerals, proteins, micronutrients and high-energ fats (Wuehler et al. 2011). Milk and its products represent ideal substrates for fermentation by various species of micro-organisms (Quigley et al. 2013). Therefore, according to Food and Agriculture Oranization (FAO) and World Health Organization (WHO), Africans started to be aware about food safety hazards accompanying milk production, processing, packaging and transportation (FAO 2003). The traditional youghurt*Nunu*is a common fermented milk product achieved by *Lactobacillus* bacteria in Ghana (Owusu-Kwarteng et al. 2017). Indigenous people of Ghana believe that *Nunu*promotes health and protects against some ailments like diarrhea and constipation (Akabanda et al. 2014). *Mabisi*is a common milk-based fermented beverage from Zambia that is rich in its nutritive composition for children under 5 years and provides healthy metabolism for the gut microbiota (Chileshe 2019). The traditional milk-based fermented diary product *ergo* is the most traditional and nutritional food supplement that is served natural or spiced for pregnant, lactating women and babies in Ethiopia (Berhe et al. 2017). In addition, studies found that the Ethiopian *ergo* reported anti-microbial activity (Amenu 2013).

4.5 Meat-Based Fermented Foods

Fermentation of meat and fish is considered one of the best ways for their preservation. In addition, fermentation increases the nutritional value of meat and fish. Fermentation process depends mainly on the enzymatic activities of muscle and intestinal tissues as well as the metabolic activity of micro-organisms (Xu et al. 2020). Salting is one of the oldest method of meat and fish preservation, and still being used worldwide. Salting process is performed either by using amount of salt 20% more than the total weight of the fish or less amount of salt about 8% of the total body weight. The traditional salted fermented fish, Hout-Kasef is one of the popular meat-based fermented food in Jazzan region in Saudi Arabia (Gassem 2019). In Senegal, Guedj fish is one of the common local fish that is processed indigenous people though salting, fermentation and finally sun-drying (Diop et al. 2019). *Faseikh* and *muluha* are traditional salted and fermented food in Sudan and Egypt. Apart from the microbial ativity of *faseikh* and *muluha*, they are consumed by local people during ceratain events for their characteristic meat taste (Nasr-Allah and Zakar 2018). A recent study reported that the lactic acid bacteria isolated from

the traditional fermented fish had probiotic activity and could inhibit gram positive and gram negative bacteria (Amarantini et al. 2019).

4.6 Conclusion

Collectively the information gathered in the present chapter reveals that fermentation process is a method that is practiced by ancient Africans to secure food demands in that big continent and improve the nutritional value of cereals, insects, diary products, meat and fish. Rural and urban communities of Africa are still practicing fermentation of different type of food products in house or industries for their increased contents of the essential nutrients as well as their health promoting activities in children and adults. Nonetheless, fermentation process of food products requires control to avoid the poinsoning risks when consumed by human.

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