ISSN: 2572-5971

Mini Review Article

Advances in Nutrition & Food Science

A Survey of Kocho Processing Practice and Challenges to Scientific Developments

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Submitted: 18 Nov 2021; **Accepted:** 26 Nov 2021; **Published:** 02 Dec 2021

Citation: *Melaku Tafese Awulachew. (2021). A Survey of Kocho Processing Practice and Challenges to Scientific Developments. Adv Nutr Food Sci, 6(2), 65-71.*

Abstract
Kocho is a food product made from the decortication and fermentation of enset parts. A quarter of Ethiopia's population lived in the south and south-western parts of the country, where staples or co-staples were used as a food source. Kocho preparation consists of several steps, all of which are still carried out using indigenous knowledge and traditional practices. Despite its benefits, enset plant processing for food preparation is time consuming, unsanitary, requires a long fermentation period, is low in protein, and has a strong odor. The unusual sensory characteristics are the result of microbial spoilage caused by Kocho's high moisture content. High moisture content encourages the growth of spoilage microorganisms, which produce unpleasant organic compounds. Kocho's nutritional and organoleptic properties may thus be process-related. Nutrient loss and time-consuming fermentation processes are common and vary by location. Furthermore, accurate understanding and introduction of these processes in both enset growing and nongrowing regions can help to improve, standardize, and increase the process's utilization in order to contribute to the country's food security. However, there has been little research on the preservation of kocho by chemical ingredients and natural species, as well as microbes involved in fermentation and spoilage. Furthermore, very few studies on the effect of biochemical and the role of fermentation on the degradation of anti-nutritional factors have been reported. It can be stored for years and, like other fermented foods, can inhibit the growth of pathogenic bacteria, extending product shelf-life while ensuring consumer safety. Above all, this review is being conducted with the goal of reviewing the kocho processing practices and challenges to Scientific developments. Similarly, the document attempts to provide a brief description of its common characteristics in terms of microbial, biochemical, and fermentation conditions.

Keywords: Kocho, Enset, Microbes, Biochemical, Fermentation Conditions.

Introduction:
Fermented kocho product is kocho food that has been subjected to the action of microorganisms or enzymes so that desirable biochemical changes cause significant modification to the food or fermented as a type 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. Kocho is an Ethiopian traditional fermented food product made by fermenting parts of the 'false banana' (Ensete ven-tricosum). It is made from the scraped pseudostem and corm, which are fermented in solid state fermentation (National Research Council, 2006).

Enset is a multipurpose crop and provides food for more than 13 million people in Ethiopia. It's one of the fourth agricultural systems in Ethiopia. Its cultivation and fermentation tradition are unique and important food sources for Ethiopia. The quarter of Ethiopian population those were inhabited in south and south western part were used as staples or co-staples food source.

Annual production of enset plant in Ethiopia is 6543 kg/ha and 4.5 million tons of kocho are available as standing stock. Relative to other crops its highly productive, drought tolerate and obtained throughout the years and stored without the need of refrigerator, where it makes a major contribution to food security of the country. Regions where enset is used as staple food are usually less affected by the recurrent drought periods that occur in Ethiopia. The overall objective of this paper is to review the characteristics of indigenous kocho processing practice and research drawing opportunity mechanisms and pathways intersection in correlation to microbial, biochemical and fermentation conditions.

Review
Challenges and kocho processing practice
Today, Kocho is processed from Enset with major concerns such

as food safety and security issues, Microbial dynamics of Enset fermentation, microbial spoilage and accompanying changes and biochemical changes during fermentation, effect of altitude on microbial successions, chemical composition and degradability, mineral content and mineral absorption inhibitory factors to improve indigenous Kocho processing.

The fermentation method and duration differ from area to area, sometimes even from household to household (supplementary figures 1-4).

(a) (b

Figure 1: (a). sheets Fermented kocho storage in plastic bags; (b). Preservation of fermented kocho with dried leaf

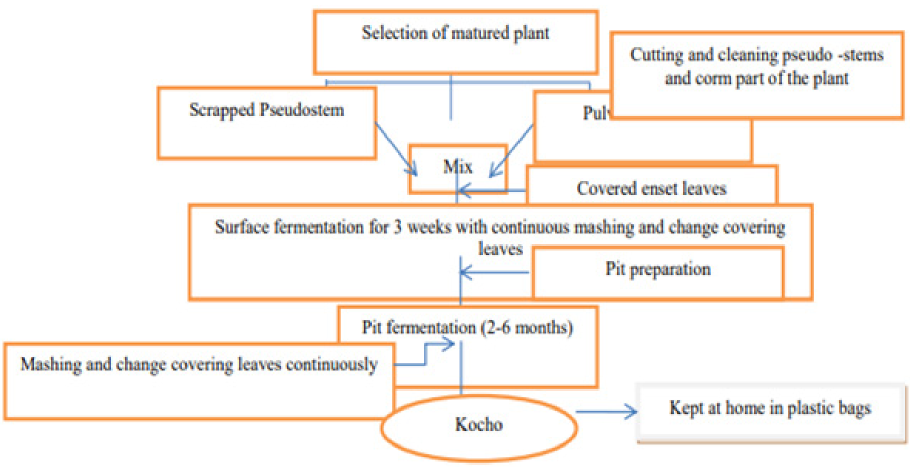

Figure 2: Diagrammatic representation of kocho production process in Ginchi

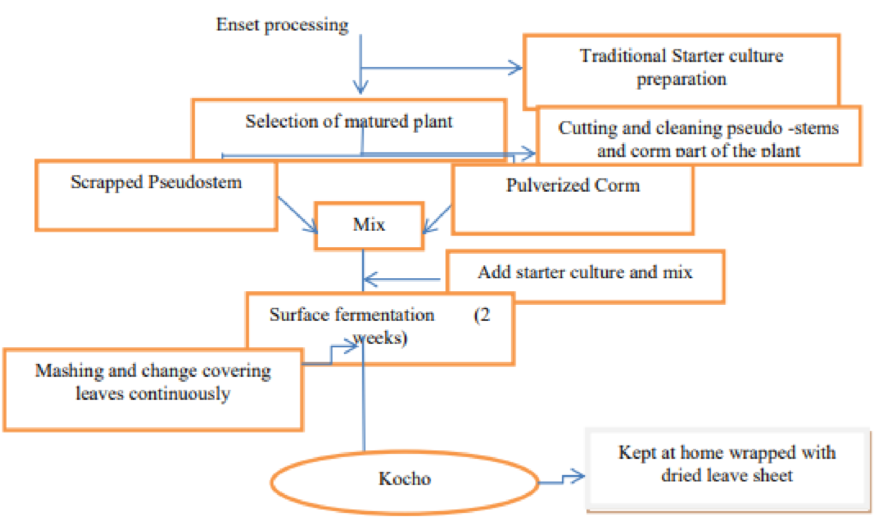

Figure 3: Diagrammatic representation of kocho production process in Gedeo zone

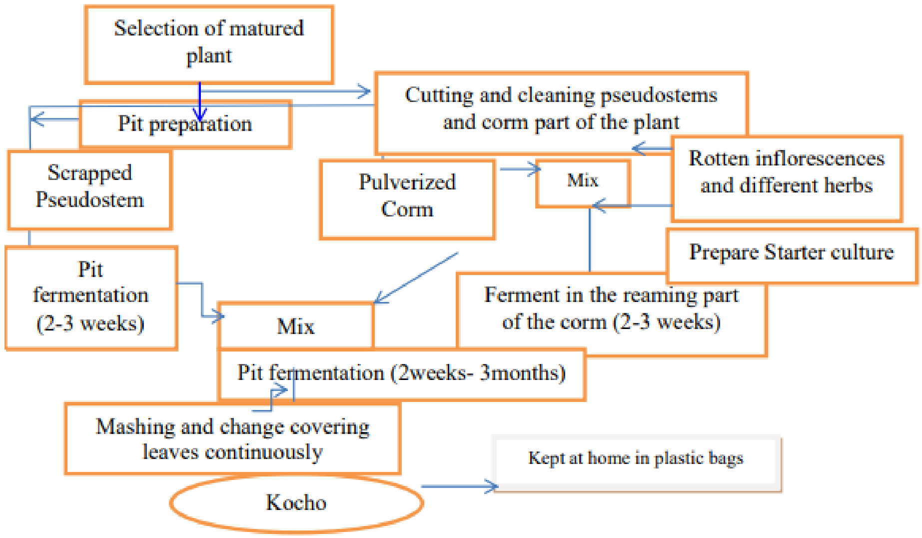

Figure 4: Diagrammatic representation of kocho production process in Woliso

According to in high altitude regions, fermentation is carried out in a pit after supplementation of a traditional starter for about 2–5 months, whereas in low altitude regions, traditional surface fermentation is followed by pit fermentation as a two-step process for about 2–4 months. In the Gedio zone, traditional surface fermentation for 2–4 weeks with the addition of a traditional starter is common. Enset processing is mostly done from October to early December, with a few exceptions from May to mid-June. Enset is typically harvested just before flowering; the best time to harvest is when the plant flowers. The length of time it takes to flower is determined by climatic conditions, clone type, and management. As a result, the flowering time ranges from 3 to 15 years, but is best around 6 or 7 years.

General understanding and Effect of Fermentation

Fermentation

Microbes have played an important role in human food production through fermentation since ancient times, originally for food preservation purposes. The technique of fermentation has been used globally to improve nutritional, safety, and organoleptic properties of food using different raw materials. Also, in Africa the technique has been used as an inexpensive method to effectively preserve and improve sensory and safety of food. The production of fermented products is based on the microbial activity that transforms a raw material into a product with increased sensory and nutritional value, leading to several known general nutritional attributes, including the following: 1) Enhanced nutritional value through the breakdown of certain constituents and anti-nutritional factors, increased availability of micronutrients such as iron, zinc and calcium, and the synthesis of B vitamins. 2) Enhanced digestibility due to the breakdown of indigestible oligosaccharides such as lactose and complex polysaccharides. 3) Enhanced food safety by protection from proliferation of pathogenic microbes by the low pH and antimicrobial compounds, which also gives the products a prolonged shelf life. 4) Elimination of toxic substances such as mycotoxins. 5) The fermenting bacteria serve as probiotics, contributing to a healthy ecology of intestinal bacteria which promotes general health.

Benefits and Pitfalls of Fermentation

Table 1. Benefits and pitfalls of fermentation.

Benefits/Pitfalls	Description
BENEFITS	
General advantages	−mild conditions (pH and temperature) − development of unique flavors and textures of food − low consumption of energy − low capital and operating costs −relatively simple technologies
Pathogenic bacteria and spoilage organisms are inhibited	The most food is fermented by lactic acid fermentation, during which pH is lowered to ca. 4. Also, bacteriocins, hydrogen peroxide, ethanol, diacetyl are produced. This inhibits the growth of unwanted microorganisms and prevents spoilage of food
Detoxification and softening	Lactic acid fermentation also may reduce the content of natural toxins in plant food: e.g. cyanogenic glycosides in cassava (major staple food in Africa) and soften plant tissues.
Enhanced digestibility – degradation of oligosaccharides and dietary fiber	Complimentary food for children containing amylase-rich flour and lactic acid bacteria. Also, fermentation of plant foods favors transformation of phytate by phytase. This increases several fold bioavailability of iron. The consequence of lactic acid fermentation is decreased tannin content in cereals, which increases minerals absorption and protein digestibility of grains.
Beneficial health effects	Fermentation improves food safety and quality through the presence of probiotics that protect from E. coli and other pathogens and have hypocholesterolemic and anticarcinogenic effects, which is of particular significance in lactose intolerance and gastrointestinal disorders
PITFALLS	
Fermentation technologies are complex and sensitive and require careful control of:	-Quality and safety of raw materials – initial level of contamination − environmental hygiene and sanitation − safety of metabolites − processing conditions and degree of acidity achieved
Risk of contamination	If the fermentation was not properly conducted, spoilage may appear which causes annoying odor, bad taste (butyric acid, hydrogen sulfide, aromatic amines). Also, there is a danger of contamination by pathogenic bacteria
Risk of intoxication	There were reported cases of dangers associated with the consumption of fermented food. In Alaska, fish, seafood and birds were traditionally fermented in grass-lined hole. In 1980's the fermentation began to be carried out in plastic containers. This resulted in the development of botulinum bacteria which thrive under anaerobic conditions and caused several botulism cases

Effect on Foods

Fermentation of foods is the controlled action of microorganisms to alter the texture of food, to preserve (by the production of acids and alcohols) and to produce characteristic flavors and aromas. Changes produced by fermentation in food are discussed in Table 2.

Table 2. Change produced by fermentation in food.

Change	Description
Texture	food is softened as the result of complex changes in proteins and carbohydrates
Nutritional value	microorganisms improve digestibility by hydrolysis of polymeric compounds, mainly polysaccharides and proteins; secrete e.g. vitamins
Enrichment with	protein, essential amino acids, essential fatty acid
Flavor	Sugars are fermented to acids, which reduce sweetness and increase acidity, in some cases bitterness is reduced by enzymatic activity
Aroma	the production of volatile compounds: amine, fatty acid, aldehydes, ester and ketones
Color	Proteolytic activity, degradation of chlorophyll and enzymatic browning may produce brown pigment

Fermentation Feedstocks /Microorganisms/

Microorganisms that are used in industrial fermentations include:

Bacteria: Acetobacter, Streptococcus, Lactococcus, Leuconostoc, Pediococcus, Lactobacillus, Propionibacterium, Brevibacterium, Bacillus, Micrococcus, Staphylococcus.

Yeast: Saccharomyces, Candida, Torulopsis, Hansenula.

Mold: Aspergillus, Penicillium, Rhizopus, Mucor, Monascus, Actinomucor.

Lactic acid bacteria (LAB) are naturally present in milk, fruit juice, plant products, intestine and mucosa. In fermentation products, antimicrobial effect of their acids is used. Lactic acid bacteria are divided into three groups: homolactic (Streptococcus spp., Pediococcus spp.), heterolactic (Leuconostoc spp.) and facultative (Lactobacillus spp.). Generally, Lactobacilli are stronger acid producers than Streptococci.

Most LAB produce bacteriocins, which reduce the use of chemical preservatives, e.g. Lactococcus lactis produces nisin which inhibits growth of Cl. botulinum and Listeria monocytogenes). Some LAB have stabilizing and viscosity forming properties. This enables us to avoid using synthetic stabilizers and emulsifiers. Yeasts are frequently minority companions of LAB and are also used to produce CO2 (in beer and breadmaking) and ethanol (alcoholic beverages). Molds are used in the production of enzymes which degrade polymeric components: cell wall polysaccharides, proteins, lipids, which is significant for texture, flavor and nutritional value of mold fermented foods.

Discussion

Kocho Human Gut Microbiota

The human gut is host to millions of bacteria and it is known that its composition is specific for every individual. However, most can be categorized as belonging to one of three groups, based on the predominance of either of the genera Bacteroides, Privately, or Ruminococcin (Arumugam M et al., 2011). Gut microbiota composition of humans is affected by changes in lifestyle and diet. The intestinal microbiota has been recognized as a vital asset for health and neuro-development and is established in the first three years of life so that its modification during this period has the potential to affect host health and development has been shown that shifts in microbiota composition towards more favorable taxa and combinations of taxa leads to better health, for instance by a better functioning immune system and protection against invasion of pathogenic bacteria via the intestine (Inconnu MA, Bird AR, 2014). this way, a healthy gut microbiota with good nutrition helps to prevent disease. Since traditional fermented foods contain a mixed community of a variety of species, they are likely to include strains with probiotic effects that thus can have an impact to better health of their consumers.

Microbial Activities in Enset Fermentation Processes

The corms of mature enset plants were used as main raw material for the preparation of starter culture. Studies reveals during fermentation of kocho, the value of pH was gradually decreased. In line with this, the number of microorganisms during fermentation of kocho was seen gradual increment. Lactic acid bacteria, Enterobacteriaceae, spore forming bacteria and yeast are reported as responsible microbes for acid production during kocho fermentation. At the initial fermentation Enterobacteriaceae increased and thereafter counts of Enterobacteriaceae reached below detectable level. According to on the day zero, Kocho has high moisture content, low titrateble acidity, near neutral pH and high soluble reducing sugar concentration when compared to the final fermentation days of Kocho. During the initial period, Kocho contained a diverse group of microorganisms such as aerobic and anaerobic spore formers, Gram negative bacteria including members belonging to the Enterobacteriaceae, lactic acid bacteria and yeasts. In indigenous fermented foods, the microorganisms responsible for the fermentation are usually the microbial flora naturally present on the raw substrate. It has also been indicated that Leuconostoc mesenteroides is responsible for initiating the fermentation of Enset during initiation period. As it was described in the previous study, because of the activities of this species and to some extent, of Streptococcus faecalis, the pH of the fermenting Kocho was reduced from 6.5 to 5.6. These organisms may be then succeeded by some of the homo-fermentative Lactobacillus species. Through the activities of the Lactobacillus species, the pH can be further reduced to 4.2. The microorganisms are also temperature dependent. For instance, if Pediococcus cerevisiae present in Kocho, it can't achieve prominence in relatively low fermentation temperature between 14°-18°C. Spore-formers may be present in fairly high numbers during the first 15 days of fermentation. The butyrous odor usually detected during the first two weeks in fermenting Kocho is due to the activities of certain clostridial species, and yeasts can be also present in fairly high numbers.

Biochemical condition of Microorganisms

Microbes, in general, require an appropriate biochemical and biophysical environment to grow and express normal metabolic activities. Biophysical environmental factors including temperature, pH, water activity, redox potential, and the presence of inhibitory compounds produce a wide range of variations among microbes' strains. The biochemical environment conditions are made available through nutrients in the culture media. In addition to carbohydrates (carbon source), culture media, bacteria produce lactic acid which conserves food. i.e., Lactic Acid Bacteria (LAB) are usually supplemented with various free amino acids, peptides, nucleic acid derivatives, fatty acids esters, minerals, vitamins, and buffering agents. The fastidious characteristics of LAB, the ability of LAB strains to produce acid and antimicrobial compounds, and the variations in nutritional requirements among LAB strains have added additional limitations and challenges with regard to developing general growth media. In addition, metabolites that are produced by some LAB strains may inhibit the growth of other strains or even the same strain such that the case of bacteriocin production. On the other hand, low nutrient concentrations may cause fast depletion in the essential nutrient which may negatively affect growth whereas high nutrient concentration such as salts could also negatively affect growth or could be insoluble in water [1-42].

Conclusion

The enset plant is one of Ethiopia's fourth agricultural systems. Its cultivation and fermentation traditions are one-of-a-kind and vital food sources for Ethiopia. Fermentation was traditionally a method of preserving food that has been used for centuries and continues to be used today. However, since other preservation techniques are available, the main purpose of food fermentation is now to produce a wide range of fermentation products with distinct taste, flavor, aroma, and texture. Using various microbial strains, fermentation conditions (microorganisms, substrates, temperature, time of fermentation, etc.), and chemical engineering achievements, we can produce hundreds of different types of foods and food acids. Surprisingly, in such a diverse range of products, flavors, and textures, only two types of fermentations are used in the majority of cases: lactic acid and ethanolic fermentation.

Concerns of enset-related research may include gaining familiarity with a phenomenon or gaining new insights into it and accurately portraying its characteristics, which may lead to minimizing post-harvest loss in terms of value addition, identifying its optimum preservative effects, or searching for an alternative to processing, packaging, and related Techniques. Furthermore, the function of both is to alter conditions so that undesirable spoiling or pathogenic microorganisms do not grow and alter the food. Natural ecosystems, on the other hand, have limited nutrient supply, long generation times, mixed populations, and continuous fluxes of components into and out of the system. The main reasons for Kocho's limited cultivation and consumption could be related to its unusual inherent sensory characteristics for non-consumers, nutrition loss, long fermentation period, lack of awareness, and its short shelf-life. Nutrient loss and time-consuming fermentation processes are common and vary by location.

Competing Interests

The authors declare that they have no competing interests.

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