International Journal of Food Science, Nutrition and Dietetics (IJFS)
ISSN 2326-3350

KOCHO (Indigenous Food Of Ethiopia): A Review On Traditional Practice To Scientific Developments

Research Article

Melaku Tafese Awulachew*

Ethiopian Institute of Agricultural Research, EIAR, P.O.Box 2003, Addis Ababa, Ethiopia.

Abstract

Kocho is food product produced by decorticating and fermenting of enset parts. Quarter of Ethiopian population those were inhabited in south and south western part were used as staples or co-staples food source. Kocho preparation composed of many steps, these all steps are still performing with indigenous knowledge with traditional practices. Despite its advantages, enset plant processing for preparation of food is time consuming, unhygienic, need long fermentation period, low in protein, and have strong odor. Those of the uncommon sensory attributes are the results from microbial spoilage due to high moisture content of Kocho. High moisture content supports the growth of spoilage microorganisms which in turn produce unpleasant organic compounds. The nutritional and organoleptic qualities of Kocho could therefore, be process related. Nutrient loss and time taking fermentation processes are common and vary from place to place. Plus, accurate understanding and introduction of these processes in both enset growing and nongrowing regions can help to improve, standardize and increase the utilization of the process in order to contribute to food security of the country. However, limited research was reported on preservation of kocho by chemical ingredients and natural species, microbes involved in fermentation and spoilage. In addition, very fewer studies were reported on effect of biochemical and role of fermentation on anti-nutritional factors degradation. Similar to other fermented food it can inhibit growth of pathogenic bacteria, extending product shelf-life while ensuring consumer safety and it can be stored for years. However, scientific review to show the kocho traditional practice and scientific research undertaken in this area is found. In considering above all, this review is under taken with objective to review the traditional practice and scientific research reported on kocho preparation. Similarly, the document tries to give a brief description of its common Characteristics with in relation to microbial, biochemical and fermentation conditions.

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

Introduction

Fermented kocho product is referred to as the kocho food which have been subjected to the action of micro-organisms or enzymes so that desirable biochemical changes cause significant modification to the food or fermented as a form of energy-yielding microbial metabolism in which an organic substrate, usually a carbohydrate is incompletely oxidized, and an organic carbohydrate act as the electron acceptor. Kocho is a traditional fermented food product in Ethiopia and is produced by fermentation of parts of the 'false banana' (Enseteven-tricosum). It is prepared from the pseudostem and corm which is scraped and fermented in solid state fermentation [29].

Enset is a multipurpose crop and provides food for more than 13 million people in Ethiopia (Guzzon and Muller, 2016). It's one of the fourth agricultural systems in Ethiopia [9]. 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 [34]. Relative to other crops its highly productive, drought tolerate and obtained throughout the years and stored without the need of refrigerator [12], 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 [9]. The overall objective of this paper is to review

***Corresponding Author**:
Melaku Tafese Awulachew,
Ethiopian Institute of Agricultural Research, EIAR, P.O.Box 2003, Addis Ababa, Ethiopia.
Tel: 0924621018
E-mail: Melakutafese12@gmail.com

Received: September 23, 2021
Accepted: December 30, 2021
Published: January 03, 2022

Citation: Melaku Tafese Awulachew. KOCHO (Indigenous Food Of Ethiopia): A Review On Traditional Practice To Scientific Developments. *Int J Food Sci Nutr Diet*. 2022;11(1):569-574. doi: http://dx.doi.org/10.19070/2326-3350-2200098

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the characteristics of indigenous kocho during processing and research drawing opportunity mechanisms and pathways inter section in correlation to microbial, biochemical and fermentation conditions.

Literature Review

Scientific Research on kocho

Characteristics of kocho related to its processing effects such as microbial, biochemical and fermentation conditions are the major concern of this document.

Limited research was reported on the major areas of kocho preparation. One of the well-studied parts was development of is reported by different investigators on Enset with the major concerns such as food safety and security issues [23]; Microbial dynamics of Enset fermentation [17], microbial spoilage and accompanying changes [18] and biochemical changes during fermentation and the effect of altitude on microbial successions [20], chemical composition and degradability in different morphological fractions [32], mineral content [5] and mineral absorption inhibitory factors, improving the indigenous processing of Kocho using different cultivars of Enset [40], differences between the pits and jars of Kocho fermentation [22].

In contrast, limited research reported on microbial characterization of the fermented batter, preservation of kocho, degradation of the anti-nutritional factors and effect of processing methods on quality of the kocho. However, research on the energy requirements, development of the kocho fermentation pans were developed and reported well. Moreover, still their a gap needs to improve and optimize of Kocho related problems and so, an integrative approach to increase its productivity and to optimize its shelf-life, food safety and quality of the products, among numerous techniques, fermentation methods and addition of traditional preservatives of plant sources are very important activities but need to optimization. Such traditional preservatives contain chemical constitutes with characteristic of flavors, antioxidant as well as antimicrobial activities.

Studies on the effect of processing methods on Quality of kocho

Kocho production is done in a ground pit, at a temperature (about 30°C), anaerobic fermentation; the starter culture is taken from amicho (formerly fermented decorticated ensetpseudosteam), which facilitates fermentation of Kocho (used as inoculation of microorganism). The fermentation method and duration differ from area to area, sometimes even from household to household (supplementary figures 2-4). According to [20], fermentation is carried out in a pit after supplementation of a traditional starter for about 2–5 months in regions at high altitude; while in regions at low altitude traditional surface fermentation is followed by pit fermentation as a two-step process continued for about 2–4 months. Traditional surface fermentation for 2–4 weeks by supplementation of a traditional starter is common in the Gedio zone [37].

Enset processing mainly takes place from October to early December and occasionally from May to mid-June [8]. Enset is usually harvested just before flowering, the preferred harvesting time is just when the plant flowers. The time duration required to flower depends upon climatic conditions, clone type, and management. Hence, the flowering time varies from 3 to 15 years but is optimally around 6 or 7 years [35].

Studies on the 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 [2]. 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 [15, 19]. 2) Enhanced digestibility due to the breakdown of indigestible oligosaccharides such as lactose and complex polysaccharides [30]. 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 [32, 11]. 4) Elimination of toxic substances such as mycotoxins [27, 36]. 5) The fermenting bacteria serve as probiotics, contributing to a healthy ecology of intestinal bacteria which promotes general health [41, 24, 30].

Benefits and Pitfalls of Fermentation:

Table 1.

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.

Fermentation Feedstocks/Microorganisms:

Microorganisms that are used in industrial fermentations include:

o Bacteria:Acetobacter, Streptococcus, Lactococcus, Leuconostoc, Pediococcus, Lactobacillus, Propionibacterium, Brevibacterium, Bacillus, Micrococcus, Staphylococcus.
o Yeast: Saccharomyces, Candida, Torulopsis, Hansenula
o 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 chemi-

Table 1. Benefits and pitfalls of fermentation.[7, 10, 16, 26, 28].

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

Table 2. Change produced byfermentation in food. [6, 16, 9].

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

cal preservatives, e.g. Lactococcuslactisproducesnisin 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 CO_2 (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

Studies reported on the 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, Prevotella, or Ruminococcus [3]. Gut microbiota composition of humans is affected by changes in lifestyle and diet [14]. The intestinal microbiota has been recognized as a vital asset for health and neurodevelopment 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 [33] as been shown that shifts in microbiota composition towards more favourable 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 [13]. 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.

Studies reported on 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 [22]. At the initial fermentation Enterobacteriaceae increased and thereafter counts of Enterobacteriaceae reached below detectable level [39].

According to [17], 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 [4].

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 [17].

Studies reported on 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 [25]. 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 [21]. 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 [25].

Conclusion

The enset plant is one of the fourth agricultural systems in Ethiopia. Its cultivation and fermentation tradition are unique and important food sources for Ethiopia.Fermentation was traditionally a process which enabled to preserve food and as such has been used for centuries until present. However nowadays, the main purpose of food fermentation is not to preserve, since other preservation techniques are known, but to produce a wide variety of fermentation products with specific taste, flavor, aroma and texture. Using various microbial strains, fermentation conditions (microorganisms, substrates, temperature, time of fermentation etc.) and chemical engineering achievements, enable us to manufacture hundreds of types of foods and other food acids. In such a wide variety of products, tastes and textures, surprising is that in the majority of cases, only two types of fermentations are used: lactic acid and ethanolic fermentation.

The concerns of enset related study may be to gain familiarity with a phenomenon or to achieve new insights into it and to portray accurately its characteristics, this lead to minimize the post-harvest loss in terms of value addition, identification of its optimum preservative effects or associated with searching an option to processing, packaging and related Techniques. Also, the function of both is to change conditions, so unwanted spoiling or pathogenic microorganisms would not grow and alter the food-Characteristics of natural ecosystems are instead: limited nutrient supply, long generation times, mixed populations as well as continuous fluxes of components into and out of the system. The main reasons to limited cultivation and consumption of Kocho could be related to uncommon inherent sensory attributes for non-consumers, nutrition loss, long fermentation period, lack of awareness and its short shelf-life. Sensory attributes of Kocho are not acceptable by most of none Enset producing areas since they are not familiar to the odor, taste and flavor of the food. Most of the uncommon sensory attributes are the results from microbial spoilage due to high moisture content of Kocho. High moisture content supports the growth of spoilage microorganisms which in turn produce unpleasant organic compounds. The nutritional and organoleptic qualities of Kocho could therefore, be process related. Nutrient loss and time taking fermentation processes are common and vary from place to place. Food taboo, lack of knowledge, experience, skills and technology in Enset cultivation, fermentation and consumption are the other drawbacks.

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Supplementary Figures

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.

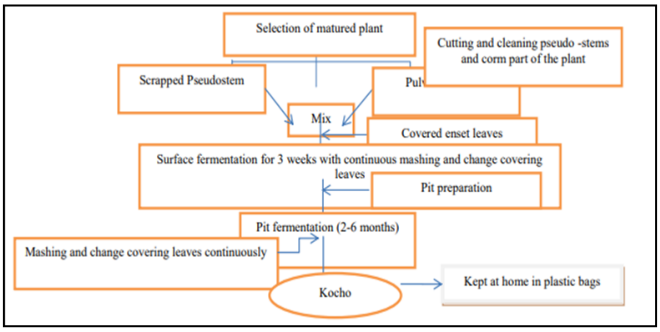

Figure 3. Diagrammatic representation of kocho production process in Gedeo zone.

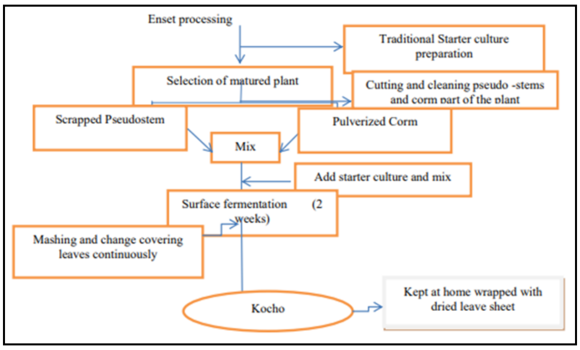

Figure 4. Diagrammatic representation of kocho production process in Woliso.