Revisit "injera" and "kocho" processing in view of food safety: A review.

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Abstract

Injera is fermented food which made from teff grain it has sponge like texture and high energy contents. It pass different steps during injera processing few of them are teff harvesting and transportation, field storage, threshing ground preparation, threshing, winnowing, cleaning, handling, sieving, milling, sieving, mixing, fermentation, backing, cooling, polyethylene warping and storage. From them some of unit operation shows food safety alarming physical hazard (soil particles, chaff, weed, other grains (barley, wheat, maize), stone (kichikichi), metals), microbial hazards (bacteria (*Salmonella*, *E. coli* and *Listeria monocytogenes*) and molds (fungal species (*Aspergillus niger*, *Penicillium* sp. and *Rhizopus* sp.) and aflatoxins)), and pesticide hazards (cypermethrin, permethrin, deltamethrin, chlorpyrifos ethyl, and DDT and its metabolites in teff grains), fertilizers, herbicides. Injera processors and researcher put good efforts in advancing injera processing techniques. Kocho is popular fermented food in Ethiopia. Kocho processing start by enset harvesting and transportation, storage, enset washing, leave sheath separation, decortication and grating, squeezing, fermentation, sedimentation, filter bag, drying, pulverizing, sieving, packaging and store. During enset processing certain food safety hazards appeared like insects, insect remains, soil, dusts and any unwanted impurities, *Clostridium* species, some mold species and certain bacteria. Kocho processing still handled by rural women no any processors or researchers trying to advance kocho processing unit operation.

Keywords: Food safety, Injera, Kocho, Physical-hazards, Microbial-hazards, Chemical-hazards, HACCP, Kocho waste, Food hygiene, Injera waste

Introduction

Food safety refers to practices and conditions that preserve food quality to prevent contamination and food-borne illnesses during preparation, handling and storage. Food should be safe for human consumption and free from hazards that may compromise the health of the consumer.

Injera is highly consumed all over Ethiopia and has slightly spongy texture. Injera is traditionally made out of teff flour. Injera is made from whole grain teff milled flour make it safe for human consumption to prevent consumer from constipation, high glycemic index, high blood pressure, fiber shortage problems. Even if the whole grain teff has these advantages the way of teff postharvest handling like filed storage, threshing, cleaning, manual dough preparation, manual baking, improper packing and storage shows alarming in food safety aspect. Postharvest handling of teff is still manual which causes mold growth during field storage before threshing this happen due to high moisture or rain. After field storage time the teff pill goes to threshing it happen on the flat ground smeared by animal dang and threshing facilitated by animal force. Soil particles or wet mad or dang contamination caused from threshing floor.

Injera preparation procedures pass through fermentation as we know modern food scientist's view recommends natural beneficial micro biota fermented food consumption contributes to reduce chronic diseases like diabetic and gastrointestinal problem. On the other hand uncontrolled fermentation time and temperature causes usually very sour injera which is uncomfortable for gastric problem consumer. The injera makers somehow they have knowledge about over souring problem but making low sour injera ("aflegna") not economical because loaf volume increase during over souring and the injera looks big and also over soured injera wanted by butcher because other grain (rice, maize, cassava, barley) mixed injera holds pure teff injera characteristics though over fermentation is preferred by injera butchers otherwise mixed grain injera lose economic value to the injera butchers.

During baking injera stay on griddle in the range from 2-3 minutes, sometimes this time varies depend on the fire strength. Still lack of temperature-time adjusted injera bakery technology causes over cooking or under cooking which decrease the sensorial and nutritional quality of injera. Usually the baked injera cooled to room temperature; it warped with polyethylene plastic and put in local injera handling materials called "mesob". Sometimes poor cooling mechanism before packaging causes moisture accumulation on the internal surface

of warped plastic and facilitated mold growth on the surface of packed injera. Packed injera most of the time stored at room temperature that favors the growth of white mold on the surface of injera. Mild moisture content of injera favors the mold growth during storage not more than one week even it stay one week which made from pure teff-flour with lower environmental temperature and proper packaging otherwise injera shelf life not more than 3-4 days.

Fully matured enset is the plant which develops kocho from it. After scraping the sheath and decortication of corm parts of enset plant; mix the two end products and stay for primary fermentation. Kocho is fermented energy rich food which made from decorticated sheath and grated corm of enset plant. Kocho preparation start from enset harvesting to kocho packaging and distribution accomplished by human labor and manual which alarms food safety risk in some unit operation. From those risk unit operations enset harvesting take pale in bare ground or sometimes covered with enset leaves or old sheath which allow soil particles to pass and also unable to protect from microorganism and predator animals. In addition to these the natural high water content of enset is difficult to make dry cleaning during harvesting on the counterpart impossible to apply wet cleaning because kocho processing and preparation take place in rural area low accesses to get water to wash enset plant to remove soil and other debris efficiently. Decortication of enset sheath and mashing of enset corm by women hand and locally available materials open access to enter harmful foreign materials and microorganisms which cause ill or death of the consumer.

Therefore, the objective of this topic is alarming the researcher, students, lecturer and responsible bodies to revise the injera and kocho processing in view of food safety.

Literature Review

Injera processing methods

Injera is produced from teff by different process. The type of injera produced here is a sourdough-risen, slightly spongy texture. As mentioned above it is the main food in the Ethiopia all the time. Mostly the pure type of injera is made from only teff flour. Due to its expensiveness of the teff many people mix the teff flour with others like maize, corn, or rice flour.

The main ingredients of the injera are teff flour, irsho (yeast), water. Injera process takes place starting from its primary production of teff.

It starts with the harvesting the teff by farmers. The farmers themselves thresh and winnow the harvested and temporarily stored teff by use animal force. Then the process will proceed by sieving and cleaning. It is made by hands the farmers use labors for this process there is no any mechanical machines or equipment and this made the work very hard for the farmers. Not only lack of the equipment there is also a problem on the threshing ground smeared dug sometimes damaged by animal foot. There is a lack of appropriate and hygienic place through the whole production process. According to HACCP principles of food hygiene a plenty of correction actions should take place in the teff processing either it scaled-up by different investors as others grains through installing teff processing industry from harvesting to packaging. After winnowing handle teff in woven sack, as the consumer or market want before milling again allowed to sifting and cleaning after these it milled. The flour collected in local sacks and the flour is ready for injera processing. First develop the yeast (irsho) then, just mix the yeast with water, and add minimum amount of water. As much as possible the mixed dough store in enclosed container for almost 3 days. After that primary fermentation takes place. Then use it as irsho during the mixing process. Then mix the teff flour with water by adding the developed irsho again this batter will stay for three days the secondary phase fermentation.

Then the next step is the absit preparation; absit is a gruel or function as a dough binder in the course of second fermentation of dough. It can be cooked by taking about 10% from the fermenting dough, mixing with water (1:3 ratio) and boiling (2-5 min) and agitating for starch gelatinization. After cooling to about 46°C, absit will be mixed into fermenting vat for the second phase of fermentation that had lasted for about 2 hr. Adding absit is also critical to develop the desired texture and consistency, as injera made without absit tends to be powdery and have fewer of the “eyes” which are so prized by Ethiopian consumers. It is important to note that tef, millet, and corn are the only grains that require absit during the process of making injera [1]. Absit is a portion of the fermented dough diluted to paste with water and then cooked and gelatinizes the starch which enhances proper fermentation of the batter (Table 1). The proper fermentation process of dough can be enabled and attained by appropriate absit cooking parameters (dough level %, agitation speed rpm and adding temperature in degree centigrade) to make good injera [2].

Table 1. *Stages of injera processing, hazards and control measures.*

Stages of injera processing	Hazard identified	Control measures
Harvesting	Hazardous chemicals and molds (aflatoxins), pesticides (cypermethrin, permethrin).	Reduce the amount of pesticides by applying integrated pest management, store after well dry and store at dry place.
Threshing and winnowing	Kechkech (stone), straw, leaves, manure, soil, weed seed.	Standard cleaning techniques.
Packaging	Local woven packaging materials not protect water.	Polypropylene or multi-layer paper bags, for organic grains, paper is often preferred.

Sifting/cleaning	Poor cleaning dust and small soil particles pass through sifter.	Standard sifter equipment or machines.
Milling	Metals (lead, cadmium, mercury, arsenic, inorganic tin)	Proper milling technology. Instead of using hammer mill.
Sieving	Over fiber content.	Standard sieve.
Mixing	*Bacteria (Salmonella, E. coli* and *Listeria monocytogenes).*	Use mixing machine Instead of using hand mixing.
Fermentation	Over fermentation, soured injera.	Fermentation time and temperature control.
Backing	Burning or black injera.	Backing time and temperature control.
Cooling	Moisture accumulation inside surface of package.	Proper cooling techniques.
Polyethylene warping	Easley moisture transfer to injera.	Chosen proper packaging materials.
Storage	Fungal species (*Aspergillus niger*, *Penicillium* sp and *Rhizopus* sp)	Use anti-fungal preservatives, proper packaging, drying, cooling.

Kocho processing methods

Enset is usually harvested after maturity signs such as, size of the central shoot, appearance of inflorescence and exposure of the corm. The maturity time of enset varies from 6 to 7 years. After screened matured enset the leaves and old sheath removed from the main plant. There are two types of enset harvesting methods either the whole enset digging with it corm and transport to appropriate temporary storage place near enough for decortication and grating or simultaneously digging and separate sheath and corm to different fragments and transport to appropriate place for decortication and grating [3,4].

Short time storage used for separated sheath and peeled corm temporary stay until decortication and grating operation start. Most of the time worker not give attention about the temporary storage they simple through the separated sheath and peeled corm on dried old sheath may exposed to insects, soil particles and other hazardous materials. Harvested enset not stay even for one day it should decorticated and grated immediately after harvested, even-though there are no research investigations that prove the deterioration time of harvested enset before processing.

Enset processing experts remove unwanted materials like soil particles, insect remains and live insects, dust and dust particles, dead leaves and other plant seed, through dry cleaning by using enset sisals and if water exited they use water most of the time the water shortage is obvious in the rural area.

Before this unit operation started processing experts prepare decortication area by covering certain degree inclined ground with removed leaves and sheaths which obtained from harvested enset plant properly to protect decorticated kocho from soil contamination and they prepare bulla collection hole (pit) at the end of prepared inclined ground. The women site on top of prepared inclined ground and start decortication of enset sheath. The women personal hygiene is curtail during decortication especially their legs because they use their legs for decortication and mixing purpose.

Most of the time processors wash their legs without detergent this cleanliness is not sufficient to protect food from contaminant microorganisms like fungi and bacteria.

The processors this unit operation to separate bulla contained water from main mass by applying pressure through their leg. The excluded water collected at end of squeezing area. The importance of squeezing is not only to obtain bull and kocho separately but also to make appropriate solid to water ratio for semi-solid fermentation take place.

During decortication and grating stage the outer part of corm pulverized shallowly and the internal part of corm rubbing with water exude from kocho the wrapped it with fresh enset leaves and left at ambient temperature for about 8 days. At the 5^{th} day, it was exposed to the sun for 5 to 12 hours and again wrapped with fresh enset leaves and allowed to further ferment for 3 to 5 days [5,6].

Kocho fermentation takes place into two phases the first phase decorticated enset sheath and grated corm mass spread on prepared area and mix with starter culture. Manually they use either hand or leg to attain proper mix during this time the workers again take care about hygienic conditions. After mix the mixed mass is wrapped properly with fresh enset leaves and allowed it to ferment at ambient temperature for around 15 days. After doing these re-mixing, mashing and changing fresh leaves every five days take place these help to aerate the mass which facilitate fermentation process. The second phase kocho fermentation started by pit preparation the size and depth depend on the amount of kocho which ferment in it after digging the pit on upper ground to prevent water logging the women cover the pit with fresh enset leaves and sheath. After properly cover the pit put the mixed mass in to a pit to ferment for additional 15 days. As a phase one fermentation continuous follow-up need again in these phase within 5 day intervals re-mix, press, mash and change fresh leaves. Fermented kocho ready for consumers after pass certain unit operations like moisture reduction, size reduction, sieving, packaging and storage. Pit kocho fermentation risky in view of microbial as well as physical hazard exposure due to these lately the consumer adopted the kocho fermentation process take place

above ground wrapped with plastic or other industrial materials.

Bulla is concentrated starch product of enset which obtained from the exuded water sedimentation of kocho; it is purely white in color. During squeezing the decorticated sheath mass and grated corm mass exude water which contain dissolved starch collected at pit after allow to sediment starch collected and may washed to remove impurity. Depend on the interest of process or consumer it passes through fermentation steps by adding high quality starter to it to maintain white color. Either fermented or unfermented bull moisture content reduced through the same unit operation with kocho that is twisting or pressing. After moisture reduction the dried bulla package as the market need size and store at room temperature due to high starch content it stay for long time without deterioration [7].

The moisture contained in bulla and kocho is removed through pressing or twisting process. The moisture content removal process performed by either in women applying their leg continuously press or using pure cloth wrapped small amount of kocho or bull in it then apply torsional force until it removes moisture to necessary limit.

This separates fiber from kocho powder. The oversized fiber remain on the top of sieve is needed for pulverization unit operation and it is given to housewife and children this is traditional view currently no such division. The pure powder under size which passed through sieve is well baked and mixed with butter and others like cabbage stew traditionally provided for husband or elder family member or if there is any gust around otherwise every family members share.

This unit operation take place after the dried kocho reaches the consumer. As described in sieving unit operation section oversized fiber remain on the top of the sieve size reduced by sharp knife called “woreme”. After size reduction either they re-sieve and collect again pure powder or baked size reduced kocho “furfurame” as it is and consumed. Finally the remained pure fiber use animal feed.

Packaging and storage in rural area accomplished by the locally available materials like either dried or fresh enset leaves and sheath parts. For packaging and they use dried enset sheath or currently available grain handling double layer bags sometimes they use after proper wash the urea and dap fertilizer handling double layer plastic bag (Table 2).

Table 2. *Stages of kocho processing, hazards and control measures.*

Stages of kocho processing	Hazard identification	Control measures
Harvesting and transportation	Soils, insects, dusts and any unwanted impurities.	Properly remove all hazards.
Temporary storage	High temperature	Process immediately after harvesting, store sparsely.
Remove dirty materials either by dry cleaning or washing	Soils, insects, dusts and any unwanted impurities	Proper cleaning.
Decorticating and grating	Harmful microorganism contamination and any unwanted impurities.	Proper washing their hands and legs with detergents.
Squeezing	Harmful microorganism contamination and any unwanted impurities.	Proper washing their hands with detergents.
Fermentation	Harmful microorganism contamination any unwanted impurities.	Develop fermentation tank.
Bulla preparation	Harmful microorganism contamination any unwanted impurities.	Proper washing their hands with detergents and use appropriate cleaning mechanism.
Pressing or twisting	Harmful microorganism contamination any unwanted impurities.	Proper washing their hands with detergents and use appropriate cleaning mechanism.
Sieve	Any unwanted impurities like small soil particles, few amount of indigestible fibers.	Use standard sieve
Pulverize	Any unwanted impurities like small insect remains, indigestible fibers.	Not use at all because completely high in indigestible fiber.
Packaging and storing	Insect attack, moisture migration, elevated temperature.	Use appropriated packaging and appropriates storage area.

Discussion

Food safety target point in kocho and injera processing

Personal hygiene of injera and kocho handlers: The number of food handlers who wear protective clothing (gown, gloves, hair restraints, hairnets) during preparing and serving food in Ethiopia less than forty five percent. Skin lesions, eye and nose discharges were observed among some food handlers. No health education was given to food handlers on personal hygiene such as washing hands before and after preparing food, trimming and keeping their finger nails clean, not wearing hand ornaments, covering open cuts and wounds with waterproof bandages, covering mouth when sneezing and coughing, and reporting to health care provider or food service

manager when having diarrhea or other communicable diseases. This has resulted in poor hygienic practice of food handlers and increased risk of food contamination by food workers which may result in the outbreak of foodborne diseases [8].

Pesticide residue in teff flour: Unlike others, a grain of teff is not affected by insect pests as the result there is no direct application of pesticide during storage. Small size grains such as millet, fonio and teff are tolerant crop to many extreme environmental conditions including water-logging and resistant to storage pests such as insects. Researchers investigated that different pesticide residues have been detected, mainly organochlorines and some pyrethroids due to environmental contamination from previous applications in the fields.

The application of pesticides for the production of teff is not common in Ethiopia; however, the grain may be contaminated from previous applications through different routes of environment. Southwestern Ethiopia detected cypermethrin, permethrin, deltamethrin, chlorpyrifos ethyl, and DDT and it metabolites in teff grains which may be form environmental contamination. This reduces the global interest of importing teff from Ethiopia unless some mechanisms are proposed to reduce the presence of such contaminants. On top of that, consumers will be exposed to harmful chemicals while consuming teff products [9]. Pesticide residues, which were present to a variable extent in the food commodities after harvesting is beyond the control of consumers. Hence, a realistic solution should be developed to tackle the problem of pesticide residues in teff where food processing could be one of the important solutions to reduce pesticide residues in different food items.

Waste management in injera and kocho processing: The Enset plant is a potential food source for about 20 million Ethiopians. Enset estimated the ratios of its components to be in the range of 6%–16% lamina, 4%–21% midribs, 46%–60% pseudostem, and 10%–30% corm. The forgotten kocho processing waste is the water that exude from squeezing of kocho traditionally they use small amount this water remove insect entered to the noise of the animals which make pain full to the animals and they make sound. This water called “mocha” which has a lot of beneficiary fermentative microorganisms. Therefore, the researcher and consumer gave attention to the waste which obtain from kocho the above indicated water allowed to settle weak starch pasty product settled at the bottom of exclude water called “karta”; it is again full of starch sometimes traditionally blended to teff-flour it is able to develop good quality injera.

Injera processing waste is not that much as kocho waste; even if it has liquid water waste which eluted from dough making equipment washed effluents. It has beneficiary microorganisms like other fermented liquid foods so instead of disposing it in to the environment there is different possibilities to develop dried starter culture from the effluents.

Time-temperature management during injera baking: Most of the peoples living in Ethiopia bake injera using biomass on open-fire stoves.

The inefficient open-fire stove consumes large amounts of firewood and produces high indoor air pollution and CO_2 emission. Three-stone-stove or a three-stand-stove is where three stones with a similar size are made from clay. The three stones are placed in a triangle to support or carry the baking pan with a diameter of 60 cm and thickness of 20 cm on average. Then, firewood is inserted into the openings between the stands for burning. While burning is taking place below the pan, injera baked on it. In the process 90% of the energy supplied is lost to the environment. Moreover the mother and child are exposed to large amounts of CO and PM which is above the WHO standard sets for safe cooking [10,11].
Three-stone open-fire injera baking stove as a references and it uses clay-made injera baking pan for injera baking processes. Clay-made injera baking pan generates high amount of burns in the baked injera [12].

Clay-made injera baking pan/metal made injera/need frequent polishing with oil or oil seeds to avoid sticking and produce good quality injera. This practice takes considerable time and power; the power and time used to regain the lost heat during polishing may exceed the power and time required during bakes intervals.

Conclusion

Certain injera processing unit operations strictly need food safety system development. Those unit operations are teff threshing field, threshing technology, winnowing and cleaning technology, sieving technology, fermentation technology, baking time and temperature management technology, packaging and storage technology.

Some kocho processing methods open access for food hazards: Harvesting and transportation technology, dry cleaning or washing technology, decortication and grating technology, fermentation technology, squeezing/drying/technology, packaging and storage technology.

In addition to processing technology defects certain processors knowledge gap in personal hygiene which will be improved through HACCP principle training. Waste management systems of both traditional foods need food safety system development in case of enset waste most of the time used for animal feed. In case injera it has liquid dough washed waste simple drain in different ditches around urban areas but in rural processors they used as animal feed.

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Conflict of Interest

The author declares no conflict of interest.

References

1. Gashe BA. Involvement of lactic acid bacteria in the fermentation of tef (*Eragrosfis tef),* an Ethiopian fermented food. J Food Sci. 1985;50(3):800-1.
2. Birke W, Zawide F. Transforming research results in food safety to community actions: A call for action to advance food safety in Ethiopia. Environ Ecol Res. 2019;7(3): 153-70.
3. Mekonen S, Ambelu A, Spanoghe P. Reduction of pesticide residues from teff (*Eragrostis tef)* flour spiked with selected pesticides using household food processing steps. Heliyon. 2019;5(5).
4. Mekonen S, Ambelu A, Spanoghe P. Pesticide residue evaluation in major staple food items of Ethiopia using the Quechers method: A case study from the Jimma zone. Environ Toxicol Chem. 2014;33(6):1294-302.
5. Ashagrie Z, Abate D. Improvement of injera shelf-life through the use of chemical preservatives. Afr J Food Agric Nutr Dev. 2012;12(5):6409-23.
6. Birhanu GA, Belay AN. Enhancing the shelf life of injera: Design of an evaporative cooler clay chamber derived from local clay in Bahir Dar, Ethiopia. Design Sci. 2023;9:e8.
7. Hunduma T, Ashenafi M. Traditional enset (*Ensete ventricosum*) processing techniques in some parts of West Shewa Zone, Ethiopia. J Agric Develop. 2011;2(1).
8. Ayele A, Sahu O. Extension of enset plant product for rural development in Ethiopia. J Agric Econ Extens Rural Develop. 2014;2(3):31-40.
9. Karssa TH, Ali KA, Gobena EN. The microbiology of kocho: An ethiopian traditionally fermented food from enset (*Ensete ventricosum*). Int J Life Sci. 2014;8(1):7-13.
10. Beyene AD, Koch SF. Clean fuel-saving technology adoption in urban Ethiopia. Energy Econ. 2013;36:605-13.
11. Adem KD, Ambie DA. A review of injera baking technologies in Ethiopia: Challenges and gaps. Energy Sustain Dev. 2017;41:69-80.
12. Tesfay AH, Kahsay MB, Nydal OJ. Design and development of solar thermal injera baking: Steam based direct baking. Energy Procedia. 2014;57:2946-55.

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