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*This book is dedicated to our two beloved families*

# Preface

Fermented foods have been an important part of the diet in numerous societies; later, fermentation has been related with numerous medical advantages. Along these lines, the fermentation procedure and the resulting fermented products have recently attracted scientific interest. Likewise, microorganisms involved in the fermentation process have recently been associated with many health benefits, and so these microorganisms have become another focus of consideration.

This book will discuss various aspects concerning fermented foods of Africa by providing extensive knowledge about chemistry and bioactive compounds of food products which will help inducers to prepare recipes. Moreover, it will provide knowledge about the nutritional value and minor constituents of these food products, which will help end users, for example, manufacturers, prepare high-quality products. The information can be incorporated into our food supply at an industrial and cost-effective scale.

This book describes how fermented foods have high nutritional values and concentrates on composition, bioactive compounds, nutrient composition, safety, and application of biotechnology in upgrading certain African fermented food products.

*The book presents 37 chapters on various fermented foods of Africa. The first nine chapters of the book deal with the origin,* history, diversity, significance, properties, and *advantages of* African fermented foods, fermenting microorganisms*,* probiotic fermented foods and health promotion, molecular techniques for microbial community profiling of fermented foods, production of industrial enzymes, and bioactive components of fermented foods. Chapter 10 describes the transcriptomic analysis of bakery products. Chapters 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and 36 cover various fermented food product contents from different African countries, investigating the nutritional values, bioactive components, phytochemical properties, conventional, and medicinal uses.

This book was written by experts from the different countries around the world to ensure that it will be of significance to the industry, medicine, food scientists, and pharmaceutical industries. Moreover, this book should interest scholarly researchers who require a good source of uses and a decent arrangement of references.

Hail, Saudi Arabia — Abdel Moneim Elhadi Sulieman
Ghibaish, Sudan — Abdelbasit Adam Mariod

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# Abbreviations

| | |
|---|---|
| DNA | deoxyribonucleic acid |
| CDNA | complementary DNA |
| RNA | ribonucleic acid |
| rRNA | ribosomal RNA |
| PCR | polymerase chain reaction |
| PFGE | pulsed field gel electrophoresis |
| FCM | fluorescence correlation microscopy |
| VNC | viable but nonculturable |
| LAB | lactic acid bacteria |
| ISO | International Organization for Standardization |
| IFPRI | International Food Policy Research Institute |
| FAO | Food and Agriculture Organization |
| SDS | Sudanese Standard |
| EC | European Commission |
| WHO | World Health Organization |
| g/l | gram per liter |
| % | percentage |
| me/L | milliequivalent per milliliter |
| me/Kg | milliequivalent per kilogram |
| ° C | Celsius degree |
| Kcal | kilocalorie |
| mg | milligram |
| g | Gram |
| GDP | gross domestic product |
| LAB | lactic acid bacteria |
| ACE | angiotensin converting enzyme |

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# Chapter 1
# Introduction: Origin, History and Diversity of African Fermented Foods


**Abdel Moneim Elhadi Sulieman**

## 1.1 The Origin and History of Food Fermentation

Fermentation is a natural process by which microorganisms such as yeast and bacteria convert carbohydrates - such as starch and sugar - into alcohol or acids. Alcohol or acids act as a natural preservative and give fermented foods a distinct coating and acidity. The key is to get the right balance. Given the history of humankind itself, it is difficult to trace the origins of fermentation. However, historians have followed the signs of fermentation in preparing foods and drinks dating back to 7000 BC.

The history of fermented food dates back to most of its food through hunting, to an organized and semi-stable life, so it has to change the way it obtains and maintains food valid for a long period of time, which requires it to use it to make use of these different methods. Which mainly depend on reducing or reducing the moisture content of food by exposing it to the sun's rays, which leads to limiting the growth of microorganisms and consequently keeping them from corruption. It is also utilized as a fermentation method, and this depends upon microbial growth and fermented products under conditions that give the resulting food the flavor. The food is non-toxic, of high nutritional value and easily digestible, which causes the person to accept those changes that have occurred due to the food because of the growth of microorganisms and people can. It is to control the fermentation conditions and make them suitable for making these changes. These methods are still used mainly in food preservation, among other methods used in preserving food in the most common to this day, but the fermentation process is the most widespread all over the world.

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## 1.2 Domestication of Fermenting Microbes

Domestication alludes to counterfeit determination and reproducing of wild species to get developed variations that flourish in man-made specialties and meet human or modern prerequisites. A few genotypic and phenotypic marks of domestication have been described in crops, animals and pets. However, domestication isn't extraordinary to plants and animal.

People in the past started to grasp the association with microorganisms in view of its advantages, to be specific: digestible food preserved for a long period of time, was less inclined to be harmful (until the turn of the last century) or basically tasted superior to unfermented foods.

Gradually strategies emerged among various cultures over the world globe for working with their nearby microorganism. Early dairy farmers learned, for instance, that by fermenting milk they could store dairy items for any longer than they would in its crude state, cheese was conceived.

Different cultures discovered fermentation created products with a scope of health conservation benefits like kimchi, tempeh, miso or even fish. The core fixing differed by whatever the neighborhood culture needed to hand - just as whatever nearby organisms jumped at the chance to eat. Microorganisms have been helping us to get nutrition from an assortment of substances that would be hurtful or difficult for us to metabolize, which is the reason fermented grains and dairy can be endured more effectively than their unfermented reciprocals.

Starting in the seventeenth century, two researchers who were members of the Royal Society in England and Holland discovered microorganisms. German researcher Cohn discovered there were various types of bacteria in the nineteenth century. His partner Robert Koch kept on investigating the role of bacteria play in causing human diseases until the mid twentieth century. Finally Louis Pasteur, a nineteenth century French biologist, is known as the "father of microbiology"for his spearheading work revealing the role microbes play in fermentation as just as less wanted results like infection and food spoilage. His invention, pasteurization, is as yet utilized today to kill microbes that could cause disease or cause food and drink to spoil (https://eatcultured.com/blogs/our-awesome-blog/fermentation-a-history).

## 1.3 Definition of Fermentation

Campbell-Platt (1987) has characterized fermented foods as those food sources which have been exposed to the activity of small scale life forms or catalysts with the goal that attractive biochemical changes cause huge alteration to the food. However, to the microbiologist, the expression "fermentation" portrays a type of energy yielding microbial metabolism in which a natural substance, generally a starch, is a natural sugar goes about as the electron acceptor (Adams 1990).

Fermentation alludes to the metabolic procedure by which natural particles (regularly glucose) are changed over into acids, gases, or alcohol without oxygen or any electron transport chain. Fermentation pathways recover the coenzyme nicotinamide adenine dinucleotide (NAD+), which is utilized in glycolysis to discharge energy as adenosine triphosphate (ATP). Fermentation just yields a net of 2 ATP for each glucose atom (through glycolysis), while oxygen consuming breath yields upwards of 32 particles of ATP for each glucose particle with the guide of the electron transport chain (BD Editors 2019).

The study of fermentation and its viable uses is named zymology and started in 1856 when French scientist Louis Pasteur exhibited that fermentation was brought about by yeast. Fermentation happens in particular kinds of microorganisms and growths that require a without oxygen condition to live, in facultative anaerobes, for example, yeast, and furthermore in muscle cells when oxygen is hard to come by (as in exhausting activity). The procedures of aging are important to the food and drink enterprises, with the change of sugars into ethanol used to create mixed refreshments, the arrival of $CO_2$ by yeast utilized in the raising of bread, and with the creation of natural acids to save and flavor vegetables and dairy products.

There are numerous kinds of fermentation that are differentiated by the end products, the most commonly utilized by humans are ethanol fermentation and lactic acid fermentation.

## 1.4 Early Fermentation

Fermentation is probably the most seasoned type of food preparing known today. A significant number of humankind's preferred food and refreshments are results of fermentation, regardless of whether naturally or prompted, for example, beer, wine, bread, sausages, and various sauces and marinades. There are a few distinct sorts of fermentations that can happen in food and liquids: alcoholic fermentation, acetic acid fermentation, and lactic acid fermentation.

**Alcoholic fermentation** is perhaps the most notable of the three sorts, its byproducts having been delighted in by human civilization for millennia.

**Acetic acid fermentation** is the procedure that starts where alcoholic fermentation finishes.. The most widely recognized consequence of this fermentation procedure is vinegar.

**Lactic acid fermentation** is believed to be the most the oldest fermentation technique, with fermented milk products being found in almost every culture around the world, and proof of their utilization returning back thousands of years.

## 1.5 Role of Fermented Food in Human Life

The main function of fermentation is to convert NADH back into the coenzyme $NAD^+$ so that it can be utiliozed again for glycolysis. During fermentation, an organic electron acceptor (such as pyruvate or acetaldehyde) reacts with NADH to form $NAD^+$, discharging products, for example, carbon dioxide and ethanol (ethanol fermentation) or lactate (lactic acid fermentation) in the process.

Some of the important roles of fermented food in human life can be summarized in economic, nutritional, and health terms:

- Adding flavor and food to food as a result of the fermentation process
- fermentation food taste process and flavor desired for Aviate gain Coordination produce important vehicles as a result of activity of micro-organisms that grow food, as are converting some vehicles food in the food to taste compounds and flavor, such as acetylcholine counting this product a many compounds producing flavor in fermented products. Aldehyde and De Acetyl
- Improving the quality of the texture during the fermentation process: 2 What is used in describing foods after the texture is an important and desirable characteristic that is used in food evaluation, which is considered to be one of the desirable qualities in the soy-made soybean soy. The fermentation of soybeans through the development of some fungi (by some Western factories) where these fungi turn these cereals into a food product for use in soups or with other dishes as a substitute for meat, and some people of East Asia grow Sudanese or coconut kernels (which are the byproducts of vegetable oil plants) after special treatment, where the breakfast converts the kesbah into a food product that is used as a meat substitute and added after slicing it to the soup.
- Fermentation saves food from corruption: 3 Food preservation from corruption is one of the most important benefits of the fermentation process. Anaerobic conditions by converting food compounds such as sugars into different organic acids depending on the type of organism, and this then becomes inappropriate for the growth of other unwanted microorganisms to reduce the acidity and acidity of the body. This way, food can be stored for a long period of time.

Food fermentation includes lactic fermentation, cell fermentation, and alcoholic fermentation. Lactic fermentation is the conversion of sugars in the foodstuff to lactic acid mainly with the formation of some of the acids in the other parts of the acid. Added to it.

Milk (milk) and its derivatives are preserved for a long period of time and can be used at different times after being converted to raw milk, for example) yogurt (method of fermentation method) and as milk is soured with milk for a long time. A high nutritional value that combines the nutritional value of yogurt (yogurt) with the nutritional value of wheat.

This process is called preserving vegetables such as calzone, carrots, cucumbers and other vegetables in food preservation, and as sometimes it is preserved foods by pickling (pickles), where these vegetables are treated as a special treatment. Minutes

approx. 2.5% food and add a saline solution of undesirable concentration and permeation to the microorganisms that are desirable for growth, and this converts the sugars present in the foodstuff under anaerobic conditions to the acidic acid control, to the acidic acid control, and to the acidic acidic acid control system. It becomes inappropriate for the growth of microorganisms In this process, two main factors inhibit the growth of unwanted organisms and some pathogenic organisms, the first factor is the salt that does not allow the growth of unwanted and unwanted and unwanted organisms. Lactic acid, acetic, biotic, etc.

Cellular fermentation is an alcohol conversion that results from anaerobic fermentation. This type of fermentation is carried out under its antenna conditions by specialized micro-organisms. It converts the alcohol formed from the anaerobic fermentation process to acetic acid which is the main component among the other compounds formed. It is added in suitable concentrations to the food subject to the pickling process, or it is added as a spice to the foodstuffs in many countries of the world.

– Biological enrichment of fermented food: 4 in fermented food compared to non-fermented food, especially for starchy food. It is noticeable that the percentage of protein increases by% on the basis of the dry weight of fermented food. These improve the characteristics of the taste, flavor, and aroma of fermented starchy foods and become easier to digest than non-fermented foods, and this increases the consumption of this type of food. The increase in the protein ratio is not limited to increasing the content of free amino acids, such as lysine and sulfur amino acids, especially in the fermentation process. Rather, it also leads to fermented legumes, and the fermented food increases the concentration of some of the food. It has been found that the consumption of peeled rice in some countries leads to the possibility of some diseases due to the content of this species.

However, when these people feed on fermented peeled rice, they do not show very low levels of B1 from food from satisfactory symptoms because the microorganisms responsible for fermentation increase the content of this type of food from the non-vitamin Liamine. The microorganisms responsible for this fermentation process also increase the content of (riboflavin) in some foods as well as vitamin Niacin, and it can sometimes increase to seven B2 in the fermented food compared to the fermented food that is not in the food.

– Fermentation reduces the proportion of toxins in the raw materials that are subject to fermentation. 5. Formed on raw materials from grains and others, especially when these materials are stored in “mycotoxin”. Mycotoxins are conditions that allow the growth of the fungi that form in them. Human health, as some are chronic failures of humans when ingested, as they cause diseases of which have a high degree of toxicity, while others cause diseases in reducing the appearance of such diseases, an important role of the kidneys and some of the troubles in the liver. And break it during the fermentation process.

The procedures and measures followed in the fermentation process, such as marinating, cooking, and others lead to the breaking and breaking of some toxins. It was

found in Neurospora fermentation that some people in Indonesia use some breakfast of 50% sex with Aflatoxin and some grains to produce fermented food substitutes for meat, it reduces the flavor of the flesh. If another type of fungus is used, it is related to sex% because the presence of these fungi along with some other microorganisms that do the fermentation process break down 70 toxins with an amount and break down the toxins and convert them into non-toxic substances. It has harmful effects on health and human life. It is well known that toxins can be disposed of in a number of ways, including physical properties that include heat and ultraviolet radiation, and other chemicals, which depend on use to destroy toxins, and to get rid of them in addition to substances that are analogous or oxidizing. Food requires sophisticated and expensive devices, as it has an impact on being very expensive, and for these reasons combined, the vital way to get rid of toxins and remove them is the best of these methods, because the thick, dirty, thick, living creatures The acidity of the medium is altered as a result of the production of large quantities of acids, particularly lactic acid, or the production of representative products by the fermenting microorganisms and, finally, by the antagonism that reduces the antagonism that reduces the antagonism that reduces the antagonism that reduces the antagonism that reduces the antagonism that reduces the antagonism that reduces the antagonization between the antagonists that control the antagonization that reduces.

It is well known that some fermented foods are consumed without cooking such as dairy products and dairy products, as well as pickled vegetables, and that some require a little required to cook soybeans five to six hours, while it takes only five to five hours. For example, this is of great importance, especially in families who spend long hours collecting and preparing materials for cooking when they are fermented, such as branches, tree leaves, and others. Fermented foods are of great importance and essential as they are foods of high nutritional value secured by the nutritional needs of proteins, vitamins and mineral salts that are appropriate to the income of the ordinary consumer in addition to being consumed with non-consumptive products.

– The fermentation process changes the composition of the elements in the raw materials: 7 The foodstuffs from which the fermented food is made have many changes, whether in the composition of the nutrients present in the raw materials or in the presence of the nutrient elements that are important in the feed. It occurs to the raw material whose chemical compounds in fermentation will not affect its content before fermentation, and a clearer example of fermentation is what happens to milk after fermentation, as it is noticed that some of the milk components increase in the proportion of lactic acid and lactic acid. Lactic acid leads to an increase in the percentage of lactic acid as well as glucose and glucose sugar in addition to increasing the percentage of some other sugars that in turn are converted to organic acids by the microorganisms that do the fermentation process in the fermentation process, between the fermentation process and the fermentation process, between the fermentation process and the fermentation process, between the fermentation process and the fermentation process, between the fermentation process and the fermentation process in the fermentation process.

Before fermentation, this has many benefits especially for people who suffer from 5% and 3% for the consumer. On the contrary, its very presence is lactose intolerance, as the presence of a small percentage Lactose intoxication is beneficial in large proportions, causing irritation of the mucous membrane of the intestine, which leads to spasms in the abdomen and severe diarrhea. The percentage of free peptides and free amino acids increases during the fermentation process due to the breakdown of the proteins present in the milk that performs important inside the stomach and intestine. As microorganisms play a role, this makes fermented brown products easier to digest in the stomach emptying process, which is faster when ingesting fermented milk compared to non-fermented milk. Among the ingredients that are increased in fermented milk, free fatty acids are observed, due to the breakdown of fat in milk and this leads to an improvement in the degree of fermentation of fermented milk and the appearance of new compounds that give flavor, taste, flavor, and flavor. Probiotics, biotech and others. Finally, the fermentation process, as it shows acids in the level of vitamins, some of which are reduced due to the consumption of microorganisms during their growth. While an increase is observed for some of them, such as folic acid, niacin, butane, and others.

## 1.6 Fermented Foods and Probiotics

Fermented foods are very rich in probiotics. And all studies now indicate the significance of a balance in the intestine between benign intestinal flora and harmful bacteria. And that this balance greatly influences our physical, mental and psychological health. It is rich in live enzymes, greatly improving digestion and excretion, strengthening the immune system, improving mood and reducing depression, increasing the absorption of nutrients from food such as vitamins and minerals especially vitamins B complex.

These benign bacteria play a big role in the body's immunity, as more than 60% of the immune cells lie directly behind the intestinal wall. Bacteria also maintain the integrity of the intestinal lining and thus prevent leakage of substances that stimulate the immune system, furthermore assist in the production of antibodies against germs. It is able to rid the body of toxins and even the heavy metals that enter it. It is a very important source of nutrients such as K2, which helps protect the body from plaque deposits and heart disease.

> People has been started realizing now the great role that these bacteria play outside the digestive tract. It has become clear that their safety is closely related to the safety of other organs *in* the body, especially the nervous system and mental health, which made scientists classify them as a new organ that we did not know about in the body, such as the heart, kidneys and the liver which has the same importance.

## 1.7 Distribution of African Fermented Foods

A wide variety of crude materials are customarily fermented in various districts regions of Africa. Accordingly, fermented foods with different attributes are delivered and they have been classified in groups, for example, fermented non-alcoholic cereals, starchy root crops, animal proteins, vegetable proteins and alcoholic beverages.

### *1.7.1 Fermented Cereal Products*

Fermented foods play a significant role in the diet of people in Africa, where a wide variety of raw materials are fermented. People in Africa usually ferment mainly cereal-based foods such as sorghum, millet and maize; roots such as cassava; fruits; vegetables, though less widely; and, to a lesser extent, meat and fish (Maria Diaz et al. 2019).

In Africa, the significant cereals of importance are maize, sorghum, and millets which are utilized to create a various amount of fermented products. An intensive survey on these African fermented cereal products and their microbial ecology can be found elsewhere (Molly et al. 2017; Blandino et al. 2003; Franz et al. 2014; Guyot 2010; Guyot et al. 2012; Hammes et al. 2005). These food products are utilized as weaning food for infants, children and adults (Lei and Jakobsen 2004; Kalui et al. 2008). Furthermore, wide scope of cereal-based fermented foods and related procedures is a declaration to cultural diversity to the capacity of people to discover approaches to create foods in various settings. The advantageous impacts are the preservation of foods and the expansion in their organoleptic qualities in view of the creation of lactic acid and other metabolites synthesized by lactic acid bacteria (Guyot 2012).

Cereals represent a significant stable food in Africa. Nutritional specialists have focused on cereal based foods from maize, sorghum and millet sources. These crops contain big quantities of carbohydrates with therapeutic properties, for example, beta glucan from barley or oat based products control cardio vascular illness in people have been accounted for (Beck et al. 2010; Shimzu et al. 2008; Karmally et al. 2005; Keogh et al. 2003). Duchonova et al. (2013) proposed that the various gainful impacts of cereal can be exploited in various manners thus structure of novel cereal foods fixings can be focused at a particular population. In addition, cereals are good fermentable substrates for the development of probiotic microorganisms (Kochova et al. 2011; Charalampopoulos et al. 2008).

**Table 1.1** Cereal fermented foods and beverages, sources and the organisms involved

| Source | Product | Fermenting Microorganism |
|---|---|---|
| Maize/ sorghum/millet | Ogi | Lactobacillus plantarum, S. cerevisiae, Candida mycoderma, Corynebacterium, L. plantarum, |
| Maize/ sorghum | Fura | L. plantarum, Pedicoccus, Leuconostoc, Streptococus, Enterococcus, S. ccereviciae Pichia anomala, Candida species |
| Maize/ sorghum/millet | Agidi | Pediococccus acidolactic L. plantarum, Lactobacillus acidophilus, Leuconostoc, Streptococcus, Bacillus, Lactobacillus fermentum |
| Maize/ sorghum/millet | Kunun-Zaki | Lactobacillus leichimani, Escherichia coli, Streptococcus species |
| Sorghum/ millet | Burukutu | Acetobacter spp., Candida spp. Leuconostoc mesenteroides S. cerevisiae, S.chaveleri |
| Sorghum/ millet | Pito | Acetobacter spp., Candida species, L. mesenteroides, S. cerevisiae S. chaveleri |

Source: Ome and Michael (2015)

#### 1.7.1.1 Microbiology of Cereal Fermentation

LAB are the most widely recognized microbe which ferment cereals. LAB for fermentation in Africa is mainstream because due to their role of preservation, improved nutritional value, detoxification, creation of flavour and smell. Four genera, which are most dominating, are Lactobacillus, Lactococcus, Leuconostoc and Pedicoccus (Salovaara 2004). Other organisms are Corynebacterium, Saccharomyces cerevisiae and Streptococcus (Table 1.1). In addition, mould species such as Aspergillus, Penicillum, Fusarium and Cladosporium may be involved.

The organisms are usually from the environment or from the previous reserved batch (backslopping). This inoculation and subsequent metabolic activities bring about expanding acidity of the medium along these lines prompting to the elimination of non-lactic acid microorganisms. Subsequent microbial succession inactivates or executes a few organisms while others proceed with the fermentation. Enduring lactic acid bacteria in the fermentation form a synergy with some yeasts. The fermentation is spontaneous as a result of competitive microbial activities. Consequently, a few strains are best adjusted with quick development thereby dominating others at specific phases of fermentation.

### *1.7.2 Fermented Vegetables Products*

Consumer trend is towards fresh, highly nutritional, Food and beverages enhanced with flavor, and rich ready-to-eat or drink (Endrizzi et al. 2006). Trends in microbiology in food include initiator use cultures with possess variable benefits (for example, probiotics activity, decrease of harmful compounds, creation of vitamins) (Bevilacqua et al. 2012).

**Table 1.2** Different classification of fermented foods

| Yokotsuka (1982) | Campbell-Platt (1987) | Odunfa (1988) | Kuboye (1985) | Sudanese (Dirar 1993) |
|---|---|---|---|---|
| Alcoholic beverages (yeast) | Beverages | Starchy roots | Cassava-based | Kissar – Staples |
| Vinegars (Acetobacter) | Cereal products | Cereals | Cereals | Milhat – Sauces and relishes for the staples |
| Milk products (lactobacilli) | Dairy products | Alcoholic beverages Proteins | Legumes | Marayiss – Beers and other alcoholic drinks |
| Pickles (lactobacilli) | Fish products | Vegetable | Beverages | Akil-munasabat – Food for special occasions |
| Fish or meat (enzymes and lactobacilli) | Fruit and vegetable products | Animal protein | | |
| Plant protein (moulds, with or without lactobacilli and yeasts) | Legumes | | | |
| | Meat products | | | |

Adapted from Dirar (1993)

Fermentation of vegetables at home is done without any additives and without exposing the vegetables to heat (cooking temperature), which eliminates most of the vitamins and enzymes in the vegetables. And fermentation of vegetables at home not only preserves vegetables, but also provides many benefits. It enhances vitamins and enzymes in vegetables, and through the influence of microorganisms in fermented vegetables on the lining of the digestive system, it improves the absorption of nutrients from fermented food and other foods that humans eat (Table 1.2).

The primary retail fermented vegetable products produced throughout the world include cucumber pickles, olives, pickles and fermented cabbage.

Fermented vegetables are identified with a few cultural aspects of people. Because of their overall nutritional properties, these products fermented vegetable foods and beverages when assessed, they comprised around 33% of the food sources every day expended around the world. They have also indicated as an appropriate transporter for probiotics. What's more, they contain an enormous scope of prebiotic compounds that can stimulate the development of beneficial bacteria. Accordingly, exploitation of the axis 'fermented foods – human health' based on plant fermentations is a promising and possible technique for what's to come. Essential comprehension of the relationship between food, valuable microbes, and mankind health can be critical to enhance food quality and to forestall (Panel et al. 2016).

Fermented vegetable products have regular qualities of high acidity and low pH that typically make them safe and microbiologically stable up and down their timeframe of realistic usability. However, endurance of certain acid-resistant pathogenic

bacteria can happen when they are not appropriately prepared or dealt with. Various additives, for example, acidifiers (e.g., acetic, lactic, malic, citric, and other acids), additives (e.g., sorbates, benzoates, sulfites, in some cases), and others can be added to pickled products to improve their safety and keeping quality (Eduardo et al. 2016).

### *1.7.3 Fermented Dairy Products*

Customary systems have dominated milk creation in Africa for a long time and still flexibly impressive amounts of milk today. These systems represent above 90% of dairy ruminant population in Sub Saharan Africa (Olaloku and Debre 1992). Inactive farmers live in similar homes throughout the entire year while transitory and transhumant farmers move in search for better fields. In transhumant systems, milk surplus is imparted to neighbors or exchanged in barter, yet is infrequently sold with the exception of by family units living close.

The total milk production in Africa was 46,907,955 millions of tonnes (FAOSTAT 2016). Larger part of which 74.05% is from cows, trailed by goat (8.74%), buffalo (6.23%), camel (5.76%) and sheep (5.23%) milk. The top six African milk delivering countries in terms of milk volume are Sudan (4,391,000 tonnes), Egypt (5,598,477 tonnes), Kenya (4,925,692 tonnes), Ethiopia (3,699,373 tonnes), South Africa (3,337,018 tonnes) and Algeria (4,241,414 tonnes): these six countries produce about 50% of African milk (FAOSTAT 2016). Only approximately 15% of the total milk produced is processed to standard products (cheese, yoghurt, butter, etc.).

Over 70% of absolute milk creation experiences casual markets or is expended on the homestead (Ndambi et al. 2007). In some countries, a few endeavors are being made so as to valorise the neighborhood dairy products. For instance, in South Africa a Slow Food Presidium has been built up to advance excellent South African Raw Milk Cheeses, such as ficks burger, ganzvlei vastrap, karoo crumble and huguenot, produced by small-scale local farmers utilizing just crude milk, adopting environmentally and welfare well disposed strategies and respecting neighborhood culture and traditions (Silvana et al. 2018).

## 1.8 Conclusion

Fermented foods are considered a favorite among some people, as they prefer to eat them alongside main dishes, due to their delicious and appetizing taste, as well as their high content of nutrients resulting from the fermentation process. Many fermented foods are produced in Africa, most of these foods are produced at home level, have a short shelf life, and safety risks increase due to uncontrolled natural fermentation. Moreover, the consumption of these traditional foods decreases due to the preparation. Raw materials for fermentation include vegetables, fruits, dairy, meat and cereals. These nutrients are naturally fermented by the microbes prevalent

in the processing environments of these fermented foods. The preparation of these foods may be improved by using bacterial strains from their natural sources and using them for controlled fermentation processes.

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# Chapter 2
# Starter Cultures: Nature, Types, Characteristics, Preparation and Maintenance


**Abdel Moneim Elhadi Sulieman**

## 2.1 Introduction

Starter cultures have many definitions. They are bacterial or fungal strains either pure or mixed, utilized to begin a fermentation process. Starter culture implies chosen strains of food-grade microorganisms of known and stable metabolic exercises and that is utilized to create fermented foods of attractive appearance, body, texture and flavour. Another definition, starter culture implies the microorganisms that are chosen dependent on their capacity to create lactic acid for curd creation and a low pH to forestall deterioration, produce metabolites that give alluring flavours: or produce enzymes that ripen the dairy product (Marta et al. 2019).

The fermentation starter or starter culture is the preparation that is utilized to start the fermentation process in in various production lines, from food plants and sustainable power source plants to biotechnology and drugs. It is a microbial culture, which actually performs fermentation. Starter arrangements help the start of the fermentation process in preparation of different foods and fermented beverages. Various bacterial and other microbial strains have been utilized either in single or in mix for creating the ideal impact in the finished product. Starter cultures are bacterial or fungal strains either pure or mixed, used to start a fermentation process.

Starter cultures which are considered as GRAS (Generally Regarded As Safe) by the US Food and Drug Administration (FDA), are able to can hinder the development of unwanted microbiota, specifically pathogenic and spoilage microorganisms (Holzapfel et al. 2003; Young and O'sullivan 2011; Fraqueza et al. 2016).

Starter cultures are derived from experimentally produced, non-specific species to obtain the final product with predictable quality and quantity characteristics. Indentation farm production can be divided into two parts. After fermentation, the

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bacteria should be treated and separated from the fermentation solution, including cultured microorganisms and the rest of the nutrient solution. First, the bacteria are separated from the liquid and concentrated: there are nozzle separators and self-cleaning tablets sterilized by steam for this step of the process (Bourdichon et al. 2012).

The concentrated culture is then transferred to a lyophilized (dehydrated) dryer and dried. Finally, the cultures are filled under tight conditions and stored at low temperatures. Fermented foods and drinks have for some time been produced without utilization of starter cultures. Conventional strategies for creation incorporate backslopping, or utilizing a limited quantity of the completed explicitly safeguarded item to inoculate a new batch, utilization of microbes discovered normally on the product, and the utilization of unique compartments that take into account endurance of the starter culture microbes inside breaks and pores, the utilization of microbes discovered normally on the item, and the utilization of unique compartments that take into account the endurance of the starter culture microorganisms inside breaks and pores.

The customary techniques take into consideration the improvement of individual assortments of fermented foods and refreshments, and they are as yet drilled today for little to mid-scale creation facilities, just as in less developed countries and in natively-type products. Customery techniques, however, are inclined to slow or bombed fermentations, defilement, and conflicting quality. Conversely, present day huge scope industrial production of fermented foods and refreshments requests steady item quality and predictable production schedules just as rigid quality control to guarantee food safety Marta et al. 2019).

## 2.2 Types of Starter Cultures

The beneficial microorganisms are used in most of the different fields of the food industry and also as a bio-enhanced food supplement. Examples include the dairy, meat and bakery industries, in the production of fermented vegetables, in the production of wine and beer, and in the manufacture of animal foods. Starter farms are cultured from experimentally produced species, indeterminate to achieve predictable reproducible quantity and quality of product.

Starters are classified under various categories according to composition of microflora, growth temperature, type of products, flavour production and type of fermentation. These different cultures are utilized in the fermentation of milk, meat, wine, fruit, vegetables and cereals. To keep up their strength, viability and appropriateness, they are prepared, packaged, bundled, frozen or freeze-dried (Surono and Hosono 2011).