

Human Journals

Review Article

July 2023 Vol.:25, Issue:1

© All rights are reserved by Jun Kobayashi et al.

Differences between Rot, Fermentation and Maturation



IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals



Jun Kobayashi*¹, Keiichi Ikeda²

¹*Faculty of Nutrition, University of Kochi, 2751-1 Ike, Kochi, Kochi 781-8515, Japan;*

²*Faculty of Pharmaceutical Sciences, Hokuriku University, Ho 3, Kanagawa-machi, Kanazawa, Ishikawa 920-1181, Japan*

Submitted: 17 June 2023
Accepted: 15 July 2023
Published: 30 July 2023

Keywords: Rot, Fermentation, Maturation, Umami, Deliciousness

ABSTRACT

Fermented foods are traditional foods prepared by fermenting raw or dried ingredients using microorganisms. In recent years, foods obtained by further maturation of manufactured foods have become popular in Japan. Many substances, including non-food items, undergo a rot phenomenon in which they are decomposed by microorganisms in the environment and returned to the soil when left unattended. Fermentation, maturation, and rot are similar processes; however, few people seem to comprehensively know their differences. In this study, we explain these differences and discuss how food is consumed.



HUMAN JOURNALS

ijsrm.humanjournals.com

INTRODUCTION

Some foods are fermented using microorganisms, which changes the taste (umami) and enables long-term storage of these foods compared to fresh foods (e.g., freshly picked vegetables, fruits, fish, and meat). A variety of fermented foods are found in various countries globally, and alcoholic beverages are some of the common ones. Foods such as beer, wine, and sake are produced through the decomposition of sugar into alcohol by yeast enzymes. Fermented foods unique to Japan, such as pickles, are limited to certain regions and may exist as special products. The roots of these foods are based on the ingredients (crops) likely to be harvested in specific regions. In addition, many of them originated from the approach of addressing food shortages by devising foods to extend their edible durations and availability even during difficult times of obtaining food, i.e., winter. Food distribution has improved significantly; therefore, accessibility should not be a concern. To appeal to external regions by preserving old traditions and continue distributing certain food as local specialties, manufacturing and sale occur in limited places.

When left for long periods of time, many materials gradually deteriorate and lose their original shape, owing to exposure to the environment, such as air and microorganisms. The so-called return to the soil occurs. Organic compounds, such as food, are often consumed by microorganisms in the environment as a source of nutrition. As a result, food may lose its taste and color or become moldy on the surface. This phenomenon is known as rot. Rot and fermentation are considered very similar phenomena, but few people seem to understand the details of these differences. The maturation of food ingredients, such as meat and fish, has been the focus in many countries, including Japan. Since maturation is also considered a similar phenomenon, this study clarifies the differences between fermentation, rot, and maturation and considers the method of food intake.

Difference between rot, fermentation and maturation

Fermentation is a process in which enzymes produced by microorganisms act on organic substances in food. The enzymatic reaction converts one substance into another, under anaerobic conditions, with limited or no oxygen¹. For example, reactions in which saccharin (high-molecular-weight polysaccharides) changes to glucose (low-molecular-weight monosaccharides), proteins become amino acids, and fats become fatty acids and glycerin

(alcohol)¹). The original substances are reduced and new substances are produced, significantly changing the taste, texture, and color of the food.

Rot means the enzymatic decomposition of organic matter by microorganisms, such as mold, bacteria, and yeast and conversion into other substances¹). This effect does not occur only in food and is a phenomenon similar to that observed during fermentation, with insignificant differences. Rot is characterized by the generation of hydrogen sulfide and ammonia gas, which are harmful and have a pungent odor, during the process of decomposing organic substance¹). Because food is not manufactured, conditions such as oxygen content are not adjusted. When humans are subject, food is considered to be rot when there is a risk of food poisoning, illness, or death when eating harmful substances or substances produced by people²). However, despite a bad smell or appearance, it may not be called rot if people like it. Examples include the formation of ammonia in kusaya (fermented fish), which some people consider the smell unique to the food and green mold on the surface of cheese (fermented animal milk and unique smell due to mold)³).

Fermentation is mainly used to produce food, whereas putrefaction can be thought of as an unnecessary process for humans. Occasionally, only fermentation is beneficial to humans^{1,4}). Fermented foods can rot if not properly preserved; therefore, increasing salt concentration or adding mold to the surface of food may protect it from rotting⁴).

Maturation is a different reaction process from fermentation and rot. Some researchers believe that maturation does not involve microorganism's microbial intervention⁵). In other words, ingredients are modified by enzymes inherent to them. Besides being a food manufacturing process, maturation improves the quality of food, such as taste, when completed food is kept under fixed conditions for a long duration¹). However, it is difficult to distinguish between food production and subsequent actions. For example, miso (fermented grain) can be said to be fermented in initial stages, and matures as it progresses further⁴). It can be consumed after fermentation completion, but can be made into a mellower and more delicious product by further maturation (the final product is the product that has undergone maturation). Wine can be produced in less than one year via alcoholic fermentation. However, vintage wines are more viscous and flavorful after aging in barrels or bottled for several decades, thereby increasing their value. In other words, fermentation and maturation differ, but the difference is vague⁴).

Examples of fermented and aged foods

Table 1 presents examples of fermented foods. Here are foods that are readily available in Japan and are familiar to Japanese people. Various foods such as sake, miso, soy sauce, and pickles can be produced by fermentation. For example, a side dish called natto can be produced by preserving soybeans with natto bacteria at low temperatures, and a seasoning called miso can be produced by fermenting soybean-based grains with koji mold. If fermented foods are not heat-sterilized or microorganisms are not removed, fermentation progresses further and may reach the rot state. When this happens, umami gets lost, sourness increases, color deteriorates, and nutritional value decreases. This is because consumption proceeds as a nutrient source for microorganisms, and it is necessary to consider the expiration date of foods, as with other foods. In some foods, microorganisms are removed (in the case of liquids such as seasonings), or enzymes are deactivated by heating to stop fermentation and stabilize taste; moreover, this is also a sterilization process that prevents rot.

Table 2 illustrates examples of aged foods. Rot is said to have four effects⁶⁾: 1) Umami increases and the food becomes delicious. 2) Amino acids increase and are easily absorbed by the human body. 3) Fibers are digested and become soft texture. 4) A mellow aroma of matured incense is emitted. Some foods have traditionally matured as a matter of course. On the other hand, for foods like meat and fish, there has been increasing attention to new cooking methods. The maturation of meat and fish uses the power of microorganisms to decompose protein into amino acids, increasing the number of amino acids and improving the flavor and aroma⁷⁾. In the case of frozen storage, microorganisms function is also suppressed, so it cannot be said to be maturing. Maturation of vegetables means storing them at low temperatures for a long period of time, whereby the sugar content increases due to the harsh unnatural growing environment for living plants. The process can be applied to onions, sweet potatoes and potatoes, and the cultivation of plants such as tomatoes.

CONCLUSION

As mentioned above, fermentation, rot, and maturation are different processes, even by definition. The differences between fermentation, rot, and maturation are insignificant, and are associated with storage conditions (temperature, duration, etc.) under which different unintended reactions may occur. In addition, maturation may proceed via continuous fermentation. It is often said that meat tastes best just before it rots, but it is believed this is in reference to the maturation of meat. To determine optimal timing, management of foods based on the knowledge and experience of maturation specialists is important^{5),6),7)}.

To provide context to the processes, several biochemical findings are presented herein. Protein is a major component of human muscles and enzymes, believed to have almost no taste in food as it is a macromolecule. The elasticity of meat and fish is a property of macromolecular proteins, and their texture (chewiness) provides a sense of deliciousness. When proteins are ingested by the human body, they are decomposed into low-molecular-weight compounds, such as amino acids, by human enzymes (proteases, etc.), which enter the body and are resynthesized into components (proteins, etc.) necessary for the body. Amino acids are not only considered as components that are more easily absorbed by the human body, but are also considered to be closely related to sweetness, bitterness, and umami because they are low-molecular-weight substances. Furthermore, the aroma upon heating is believed to be due to the Maillard reaction occurring in a specific amino acid^{8),9)}. Thus, an appropriate amount of protein and amino acids is a factor that contributes to food deliciousness. Further decomposition of amino acids produces harmful substances such as ammonia and hydrogen sulfide. These substances do not easily occur in the human body and are quickly converted to less toxic substances, such as urea; however, it is often necessary to suppress their production in food production. Excessive protein changes in any maturation technique lead to rot, with odors from hydrogen sulfide and ammonia generation. While some consumers favor such odors, many do not.

Fermented foods are often considered beneficial to the body. This is because the nutrient components in fermented foods are already low in molecular weight and are easily absorbed, and the microorganisms used for fermentation are supplied to the intestines in large quantities, which is thought to contribute to the enrichment of the intestinal flora⁴⁾. However, rotten food should

not be consumed because harmful toxins may be produced during the decay process. If the maturation process is optimum, it is believed that the taste and texture of aged foods improve and this is preferred by many people. Thus, in many cases, the value of such foods increases, and it is recommended that they be consumed. If the maturing conditions are inappropriate, rot occurs. The value decreases and the benefits of ingesting nutrients from this food is difficult; therefore, this food should not be consumed. Appropriateness of the maturation process can be verified by bad smell or appearance of food⁵⁾; however, if this is difficult, using a trusted store to check or refrain from consuming such food is advisable.

REFERENCES

- 1) The difference between fermentation, spoilage, and maturation! -Benefits from microbes learned from definitions and mechanisms. Deshabro.com, published May 28, 2022, <https://deshablo.com/2018/0815/hakkouhuhai/> (browsed April 2023).
- 2) Kuniko Aida. (2020) The study of traditional fermented foods from the food culture, food hygiene and biological point of view. *Journal of Cookery Science of Japan*, 53, 69-73.
- 3) Takeo Fujii. (2011) Differences between fermentation and putrefaction -Shiokara, kusaya, and funazushi. *Journal of The Brewing Society of Japan*, 106, 174-182.
- 4) What is the difference between fermentation and spoilage? Marukome, *Fermented Gastronomy, Web Magazine*, published October 25, 2018, https://www.marukome.co.jp/marukome_omiso/hakkoubishoku/20181025/10134/ (browsed April 2023).
- 5) Do you know the difference between “aged meat” and “rotten meat”? Complezzo.jp, published November 9, 2020, <https://complezzo.jp/15366/> (browsed April 2023).
- 6) What is maturation? -The difference from fermentation and the reason why aging makes the ingredients more delicious. Umami of Japanese food, About Us, published December 1, 2020, <https://www.kobayashi-foods.co.jp/washoku-no-umami/jyukuseitoha#:~:text=1> (browsed April 2023).
- 7) What types of fermented foods are there? -List of major fermented foods. Umami of Japanese food, Basics of Japanese cuisine, published June 22, 2022, <https://www.kobayashi-foods.co.jp/washoku-no-umami/hakkou-table> (browsed April 2023).
- 8) Jun Kobayashi, Yukiko Sumida, Keiichi Ikeda. (2022) Alternative functions of amino acids and their effects on human physiology. *International Journal of Pharmacy & Pharmaceutical Research*, 25, 184-191.
- 9) Jun Kobayashi, Yukiko Sumida, Keiichi Ikeda. (2022) Can the reaction that makes food delicious be harmful? *International Journal of Pharmacy & Pharmaceutical Research*, 25, 212-220.

Table 1 Examples of fermented foods

Kind of ingredients	Food examples	Explanation
Beans	Natto	-Food made by fermenting soybeans softened by boiling or steaming with <i>Bacillus natto</i> .
	Soy sauce	-Liquid seasoning made mainly from grains, fermented with koji mold, lactic acid bacteria, and yeast, and then filtered.
	Miso	-Food made by adding salt to grains such as soybeans, rice, and wheat, and fermenting it with koji mold.
Seafood	Katsuobushi (Dried bonito)	-Food made from skipjack tuna of the mackerel family, grated into three or more pieces, formed into a boat shape called fushi, and then processed with katsuobushi fungi. Drying and adding katsuobushi mold to the surface prevents rotting and enables long-term storage.
	Salted fish	-Raw seafood meat and internal organs pickled in salt, fermented with enzymes and microorganisms of the ingredients themselves, and preserved with a high concentration of salt.
	Kusaya	-Fish such as Kusayamoro are soaked in a fermented liquid called kusaya liquid, which has a unique smell and flavor similar to fish sauce (soy sauce derived from fish), and then dried in the sun.
	Fish sauce	-Liquid ingredients made by pickling fish with salt, autolyzing it, and fermenting it with the action of aerobic bacteria.
	Funazushi	-Crucian carp pickled in salt, followed by pickling with rice for over a year to allow it to ferment naturally. Lactic acid bacteria and yeast are said to give it a unique flavor.
Milk products	Cheese	-Made from milk obtained from livestock such as cows, buffaloes, sheep, goats, and yaks, emulsified by lactic acid fermentation and citrus juice addition, and then heated to solidify. Various bacteria such as propionic acid bacteria, linen bacteria, blue mold, and white mold change the taste and increase the storage stability, and can also be used.
	Yogurt	-Semi-solid food made from animal milk and fermented with lactic acid bacteria and bifidobacteria.
	Sour cream	-A food product made by fermenting milk cream with lactic acid bacteria.
Vegetables and fruits	Nukazuke (Pickles)	-Pickles are mainly vegetables soaked in vinegar or soy sauce to soak up the flavor. The taste may be changed by using lactic acid bacteria, butyric acid bacteria, and <i>Bacillus subtilis</i> . Nukazuke is a type of pickle made from rice bran, and is made by pickling vegetables and other ingredients in rice bran fermented with lactic acid bacteria.
	Kimchee	-Vegetables such as Chinese cabbage, salt, chili pepper, salted seafood, and garlic are the main ingredients of the Korean Peninsula's typical pickles. By storing it for a long time, fermentation progresses and the taste changes.
	Pickle	-Vegetables are pickled in a seasoning liquid based on vinegar and spices. There is a fermented type (increases sweet and sour taste) and a non-fermented type.
	Wine	-Drink made by fermenting grapes with yeast to convert glucose into alcohol.
Cereals	Sake (Japanese sake)	-An alcoholic beverage made by fermenting rice with koji mold, yeast, etc. and filtering it.
	Amazake (Sweet sake)	-A sweet drink made by fermenting rice porridge mixed with koji mold.
	Rice vinegar, black vinegar	-A seasoning made from rice or black rice with acetic acid bacteria.
	Mirin	-Light yellow sweet sake made by fermenting (saccharifying) steamed glutinous rice and rice koji with shochu, often used as a seasoning.
	Beer	-An alcoholic beverage made by fermenting barley with brewer's yeast and filtering it.
	Bread	-Staple food in the West, made by fermenting wheat flour with yeast or lactic acid bacteria and then baking it.
Others	Black tea	-Tea is made by plucking young leaves of the tea plant, withering, rolling, fermenting and drying.
	Oolong tea	-Semi-fermented tea is made by heating tea leaves halfway through fermentation to stop fermentation.

Based on references 1), 3), and 7).

Table 2 Examples of matured foods

Food type	Kind of ingredients	Explanation	Frequency of maturation
Wine	Fruits	One of the most widely consumed alcoholic beverages in the world. Although it can be produced in as little as one year, aging at a low temperature changes the taste and often increases the price. Even after the wine is bottled, it continues to age and its flavors continue to change.	○
Cheese	Dairy products	Fresh cheese is basically not aged, but there are types that are lightly aged. Mildew cheese (white cheese) is made by planting white mold on the rind and maturing it, and is characterized by its soft, creamy taste. Blue mold cheese (blue cheese), contrary to white mold cheese, is made by planting blue mold inside and maturing it, so it is characterized by the fact that the inside is also filled with blue mold mycelium. It has a pungent taste and many of them have a strong salt content.	○
Meat	Meats	The meat itself can be used as food without being matured. However, in recent years, at restaurants that serve steaks and grilled meat, there are cases where customers can enjoy the change in taste and texture by aging the meat before serving it to customers.	△
Raw ham		Ham is made from pork thighs that have been salted, smoked and dried without boiling.	○
Fish	Seafood	Fish can be used as a food product without being aged. However, if it is sandwiched between kombu seaweed or matured in salt water, the amount of amino acids increases and a unique sweetness may be produced. Maturation is mainly done at dried fish factories.	△
Sweet potato	Vegetables	Storing harvested vegetables at a low temperature for several months increases their sweetness.	△
Potato		This change in taste is thought to be due to the polysaccharides of the plant itself being decomposed into monosaccharides and oligosaccharides	△
Onion		without the action of microorganisms.	△
Miso	Cereals	Food made by fermenting grains such as soybeans, rice, and wheat with salt and koji, and one of the traditional foods of Japan. The color of miso is due to the Maillard reaction between the protein and sugar content of soybeans and koji. Using a lot of strongly steamed soybeans and maturing them at high temperatures for a long time, the color becomes darker and becomes red miso. On the other hand, boiled soybeans, from which the sugar and protein have been washed away, are combined with a large amount of refined rice and strains of koji that are less colored, and aged for a short period of time to produce white miso.	○

○: It is natural to be matured; △: There is a case where it is matured.

Based on the contents of references 5) and 6).