

doi: <https://doi.org/10.20546/ijcrar.2022.1007.009>

## Review on Factors that Influencing Microbial Growth in Food Spoilage

**Kebede Dida Ariti<sup>1</sup> and Kedir kebero<sup>2\*</sup>**

<sup>1</sup>Department of Nutrition Food Science and Technology,

<sup>2</sup>Department of Agriculture, Hawassa University, Ethiopian Institute of Agricultural Research, Melkassa Agriculture Research Center, P.O. Box 2003, Adama, Ethiopia

\*Corresponding author

### Abstract

The microorganism, types, and growth at the food are summarized in this analysis. They can vary in degree depending on how much food is extruded inside of the properties due to metabolic activity. The conditions, such as water activity and moisture content, that must be a source of microbial growth in a food-based product are described. The nutrient content of the food products causes the growth of numerous microorganisms as a result of spoiling and food poisoning. The vast majority of internal elements and the sound of the food product both boost the bacteria' growth. Extrinsic and intrinsic elements must normally be distinguished as two categories. Intrinsic elements are the parameters that are innately listed on food products. Concerning the safety of specific foods have arisen due to changes in the content and characteristics of some foods as well as the development of food products to satisfy customer demands for convenience, health, and nutrition. Certain items' microbiological safety concerns also result from the development or acknowledgment of the significance of certain microorganisms that cause food deterioration or infections, as well as changes in techniques for handling, storing, and preparing food. These circumstances demand ongoing reevaluation of the variables that affect microbial growth control in order to preserve foods and keep up the safety and quality of them. Hence these factors and their influence with other can help us in the formulation of strategies for prevention of growth of spoilage organisms and food-borne pathogens.

### Article Info

Received: 05 June 2022

Accepted: 28 June 2022

Available Online: 20 July 2022

### Keywords

microorganism, water activity, temperature, extrinsic, intrinsic, PH.

### Introduction

Food spoilages are a critical which reason meals-primarily based totally product to be beside the point for human makes use of due to modify in sensory characterizes. It may to be consume, do now no longer case infection because of that no microbes available, occurred, despite the fact that alters in organoleptic purpose them to be limited (Burkepile *et al.*, 2006). Many spoilages of meals for meals for human intake are

because of microbials, that productively evaluate with man or women for rejected and treasured meals resources. Unprotected foodstuffs, microorganism and fungi quick colonize, more desirable in populace, and generate poisonous and unwanted chemicals (Blackburn, 2006). To help guard microorganisms because of meals spoilage, human beings use not unusual place techniques: 1. Block colonization with the aid of using lowering get entry to prone foodstuffs and 2. Preventing populace increase and limitation populace length with

the aid of using generating unwanted surroundings. Chemical reactions that purpose disrespected sensory modifications in ingredients are mediated with the aid of using lots of microbes that use meals as a carbon and strength source. These microorganisms like precise-celled organisms absent said nuclei and different precise yeasts and mould with nuclei. Some microbes, which includes lactic acid microorganism and molds, discharge compounds that killing competitors (Gram *et al.*, 2002). The functionality of microorganisms to grown in a meal is determined with the aid of using the food surroundings in addition to the surroundings where in the meals is stored. The foods with the aid of using their nature are wealthy in carbohydrates, proteins, and fat/lipid that microbes in addition to human being discover very nutritious. More diverse microbes can also additionally substantially be capable of use the vitamins in foods however a few spices have an aggressive gain below positive situation (Pitt *et al.*, 1997).

### Intrinsic factors

The maximum parameters that are inherent to meals merchandise are known as to as intrinsic elements (Morris, 1962) a number of the elements are pH; maximum microorganisms develop pleasant at pH values round 7.0 (6.7-5), whilst small grown much less than 4.0. Most organism closer to be many fastidious of their accomplice to pH than molds and yeast, with the pathogenic microorganism being the maximum fastidious. Water interest or moisture content; water necessities of microorganism need to be defined in phrases of water interest with inside the environment. The parameters are referred because the ratio of the water strain of the meal's product vapor strain of natural water at the same temperature  $a_w = p/P_o$ ; in which a P is the vapor pressures of the dissolved and  $p_o$  is the vapor strain of the usually water (Christian, 2016). Totally, a few microbes located extra values of water interest for increase than different fungi, with gram-poor microorganism which having extra fulfillments than gram-positive. The spoiled microbes did now no longer develop under neath  $a_w = 0.91$ , that spoilage molds will be develop as much less as 0.08. The reduction - oxidation potential, food content anti-microorganisms' constituent, organic traits; animal in addition to plant which derived ingredients merchandise, especially with inside the uncooked described have organic traits which would possibly define the access and increase of pathogenic microorganisms without organic systems consequently will be relevant in protective the access and inline increase of microorganisms.

### Water activity

The food merchandise that given through microorganisms ought to be soluble in water to by skip via out the membranes and gain into the molecular. The to be had of water is likewise crucial for the chemical reactions with inside the molecular and for by skip of vitamins and wastes in to and out of the molecular. The water requirement of microorganisms in ingredients is definitely defined in phrases of water interest of the meal's retailer. The water activity of natural water is 1 and which of absolutely dry meals is 0. Addition of solute ends in a lower water activity due to the fact those solutes tie up with their molecules.

### pH

The pH is relating to shown, the acidity or alkalinity of a dissociation. It is likewise referring because the poor logarithm of the hydrogen ion awareness and is a dedication of the hydrogen ion hobby of a dissolved.  $pH = -\log [H^+] = \log (1/H^+)$ . The pH scale varies from 1. 0 to 14.0. The pH affecting the boom of microorganism and species-smart decide pH boom premier and pH boom varies exist. Many microorganisms and protozoans are neutrophiles, fungi like acid environment approximately pH 4 to 6; algae also are regarded to choose slowly acidity. The drastic in cytoplasmic pH might be chance microorganisms through disrupting the plasma membrane that killing the enzymes hobby which delivery proteins. The consequences of inner pH are death, which greater beneath five as much as five.

The consequences of inner pH are death, which greater beneath five as much as five. Some what the decreasing of the ion with inside the availability of the vitamins is probably gift due to the outside pH changes. At a PH stage much less than 4.6, pathogens develop very slowly with positive exceptions. Many pathogens might be alive in foodstuffs at pH stages decreases than their boom minimum.

### Extrinsic Factors

The extrinsic elements are elements with inside the surroundings and outside to the meals, that have an effect on each the microorganisms and the meals merchandise itself in the course of processing and garage which include garage temperature, relative humidity, gases, and sports of microbials. It is a relevant in microbial boom in meals carries the environmental scenario in that its miles stored (Montville *et al.*, 2001). Storage temperature;

ingredient is uncovered to numerous temperatures from time of manufacturing non the less to the time of intake through consumers. Microbes boom is finished through enzymatic reactions which are relied on temperature. They not unusual place microorganism which are concerned in meals *C. botulinum*, *C. pefringens*, *B. cereus*, and *Bacillus anthracis* (*B. anthracis*).

These microorganisms are typically passed off anywhere with inside the surroundings, which might be cause them to difficult to govern in a meal processing facility (Tanaka *et al.*, 2016). The humidity is a dedication of water hobby of the fuel line type. The more relative humidity impacts the water hobby content material of the meal's product and more water content material affords microbe boom. The spots of the opposite microbes; presence and/or absence of different microorganisms affects microbial and the type of microbial populations.

### Presence and awareness of gases

They have to obligate aerobes are an organism which develop completely in oxygen awareness equivalent. It acts because the shipping the electron acceptor for the terminal chain in cardio respiratory and employs it with inside the synthesis of sterols and unsaturated acids.

The facultative anaerobic are, microorganism which might be do now no longer depending on oxygen awareness however develop higher in its available. A microorganism that grows in oxygen awareness among the range of 2% to 16% however are killed through ordinary atmospheric tiers of oxygen (20%) are microaerophilic. Most of medical investigations have proven the antimicrobial interest of gases at room and sub-room pressures towards microorganisms is essential in cattle merchandise (Loss and Hotchkiss, 2002). Carbon dioxide, ozone, and oxygen are gases which are at once poisonous to sure microorganisms.

Carbon dioxide soluble with inside the foods and lowest the pH of the foods. Carbon dioxide is defensive towards obligate aerobes and at better tiers ought to deter different microorganisms. Totally, the killed consequences of carbon dioxide greater collectively lowering temperature due to the improved its dissolved at decrease temperatures (Jay, 2000). The nitrogen, being an inert gas, has no direct antimicrobial properties. It is kindly used to displace oxygen with inside the meals bundle both best or in collectively with carbon dioxide, for that reason having an oblique killing impact on cardio microorganisms (Loss and Hotchkiss, 2002).

### Temperature

All microorganisms grown in a particularly varies of temperatures that consists of a minimum, and most efficient temperature. The length of the time and lag segment of an organism is significantly depending on temperature (Mossel *et al.*, 2015). The logicism boom quantity regular is come about to be proportional to the reciprocal of the prefect temperatures. During the most for a particular microbe, the boom charge reduces maximum fast than while temperatures technique the minimum for which the same microorganism. The small temperature the microorganism boom lets in the equation of (Jay, 2000) where in because the  $r = \text{boom charge} = \text{slop of the regression line}$ ,  $T = \text{temperature}$ , to conceptual temperature of do now no longer the metabolic Significant. The decrease temperature, the elements manage the factor at that boom limits; the response quotes for the only enzymes with inside the organism come to decrease in addition to the bottom temperatures reduced the fluidity of the cytoplasmic membrane, thereof influencing collectively shipping mechanism (Mossel *et al.*, 2015). The extra temperatures, structural molecular additives come to inactivate and denatured to thermal warmth touchy enzymes occurs. Whereas the boom charge unexpectedly will increase collectively improving temperature, the charge has a tendency to lowering fast thereafter, non the less the temperature better is dramatically reached. The temperature at once influencing microorganisms because the maximum relevant component that affecting the impact is temperature sensitivity of enzyme catalyzed reactions. The microorganism boom slowest down amongst a maximum temperature. Plasma membrane is also detrimental as fats bilayer without problems melts and harm is like a volume which it couldn't be rehibitate. At the very low temperature, the membranes solidify and enzymes don't carry out fast. The cardinal temperatures trouble notably microorganisms.

### Relative humidity

There is an affiliation amongst relative humidity and temperature. The maximum temperature, th bottom is relative humidity and vice versa. The cattle merchandise present process floor spoilage from molds, yeast, and sure microbial have to be saved in a state of affair very low relative humidity. The floor of irregularly packaged and now no longer included meats along with red meat cuts and entire bird damage unexpectedly with inside the fridge earlier than deep spoilage presents. The predominant instance of this floor spoilage is the better

relative humidity in fridge except the cardio nature of floor spoilage organisms (Mossel *et al.*, 2015).

### **Categories of Food Commodities**

The animals and flora are the not unusual place origins of meals for all microorganisms on earth. The meals merchandise acquired from animals is the predominant supply of protein and consists of fish, milk, meat, poultry, and cheese. While flora offer us with culmination and greens which can be a crucial supply of proximate composition; different ingredients coming from flora such as several grain, and so forth are an applicable supply of carbohydrate to human beings. The meals which we eats are coming from both of the animals and flora. In generally, the processed meals merchandise that we consume in each day lives is an aggregate of diverse substances which might be authentic from both flora or animals (Ali *et al.*, 2013).

### **Preservation strategies of plant food merchandise**

The meals preservative refers to strategies used for defend meals from getting spoiled. Ensuring which harvested commodities are alive with sustained chemical and respiratory methods and the want to hold the moisture content material and best of produce for the duration of garage and to limit sicknesses are important steps in postharvest garage (Young *et al.*, 2008). Extending the shelf existence of ingredients is primarily based totally on stopping enzymes in meals, stopping microbial deteriorative method, and fending off mistaken postharvest dealing with practices. Therefore, its far crucial in growing the shelf existence of meals and making sure meals protection (Lee *et al.*, 2000).

### **Preservation strategies of animal food merchandise**

The animal of ingredients along with meat, fish, milk, and eggs may want to doubtlessly be infected with a few of the lots of artificial chemical substances which can be utilized in society. Relatively few of those gifts with any regularity in ingredients from animals, however the maximum contentious radius are antibacterial pills, hormonal increase promoters, pesticides, commercial chemical substances and heavy metals. Also, a commercial chemical substances and heavy metals which aren't used truly for agricultural functions can contaminate animals' feeds thereby acquire get entry to milk, meat or eggs. The meals protection has subject on animals' sicknesses, which may be transmitted to guy from residues of environmental chemical substances,

pills, and extraordinary poisonous dealers that may save in animal tissue. Many scientists nonetheless now, meant which public fitness had been encouraged completely through microorganism that made animals sick. The disorder dealers had been covered through making sure which handiest wholesome animals entered the meals intake. The extraordinary zoonotic disorder agent along with chemical environmental, pills in addition to different poisonous dealers had been eliminated through residue analyzing programs. The hazard evaluation and vital manipulate factor structures are successful meals generating establishment, like meat packing flora, to isolate and compare the meals protection dangers that would affect product protection. The excellent control exercise and the hazard evaluation are the principal factors on this technique. The cattle manufacturers and meals animal veterinarians need to be aware about the changing necessities for farm animal protection meals as chance evaluation and hazard discount spots and up more and more not unusual place. It is beneficial with inside the growing countries, which milk should be competently cooled, absolutely be pasteurized to defend bacterial increase and improvement of heat-resistant microbial toxin (OIE, 2017).

### **Parameters to Reduced Food Spoilage**

Some instances in a meals gadget the opportunity of manage the method to killing greater pathogen in a meal's gadget, it's far from time to time feasible to control the method to inhibit one or greater pathogens in severe condition, for example, a product where in the water hobby has been reduced to 0.85 or below. In protective ingredients, definitely a couple of elements is delivering on to govern microbial increase to save you spoilage or meals born disorder. Suitable combos of increase proscribing elements may be devised in order that the organisms of subject can no extendedly proliferate with inside the product (Mossel, 1983).

### **Chemical parameters**

The discount of meals spoilage through the usage of chemical strategies is a not unusual place method. Using preservatives like, salt sugar, natural acids, smoking, and spices to inhibit the increase of spoilage microorganisms is normally relevant through the peoples. Therefore, to make sure powerful renovation the usage of chemical parameters is a powerful method.

Salt, sugar, and benzoate are extensively used with inside the meals industry. Salt is a bactericidal agent that may

be used to keep fish or pork, both as dry salt or brine, at the same time as sugar is a prime factor of jams and jellies. Sugar acts in the same manner as salt, inhibiting bacterial increase after the product has been heated. To make sure powerful preservation, the overall sugar content material need to at the least make as much as 65% of the load of the very last product. Acetic acid is used as a preservative in pickling relishes and different ingredient which have been heated. Sodium benzoate is utilized in fruit merchandise to defend in opposition to yeasts and molds and its very last attention need to know no longer be greater than 0.1 % (Nwanekezi *et al.*, 2005). Calcium propionate can be introduced to baked ingredients to inhibit molds. Sulphur dioxide authorized to be used in a few countries, may be introduced to dehydrate ingredients for shade ion retention. Preservation of lipid containing ingredients from the improvement of objectionable hues and taste and from the formation of decomposition merchandise that may be poisonous has been documented (Sims *et al.*, 1977). The smoke is acquired through burning hickory or comparable wooden beneath a low draft. During the technique of smoking, the preservative movement is supplied through bactericidal chemical substances like formaldehyde and creosote with inside the smoke and through the detachable that happens with inside the smoke house.

### **Physical parameters**

Reducing the spoilage of meals merchandise with the aid of using the use of bodily parameters is a great approach because of there being better postharvest losses with inside the agriculture practices. Dehydration; elimination of water affords higher safety in opposition to the maximum most important reasons of meals spoilage. Microorganisms cannot develop in a water unfastened environment, enzyme pastime is absent, and maximum chemical reactions are exceedingly retarded (Raj *et al.*, 2006). Packaging; the applicability of packaging and coffee temperature garage of foods, will increase shelf existence with the aid of using reducing the increase of spoilage organisms, and lowering physicochemical and biochemical degradation tactics in addition to preserving the dietary and sensory attributes of minimally processed plant foods (Hussein *et al.*, 2000). Canning; that is generally known as sterilization due to the fact the warmth remedy of the meals eliminated all

microorganisms which can ruin the meals and people which can be dangerous to humans, together without delay pathogenic microorganisms and people that produce deadly toxins. Most industrial canning operations are primarily based totally at the precept that the destruction of microorganisms will increase 10-fold for every 10 diplomas Celsius growth in temperature. Food uncovered to excessive temperature for handiest mins or seconds keeps extra of its herbal flavor. Pasteurization blended with micro filtration may be used to increase the shelf existence of milk. Milk packed in sterile packing containers and uncovered in short to temperatures better than the ones required for pasteurization can be saved unopened for months without refrigeration (Pal, 2014). High strain processing; there are a few not unusual places example of bodily methods. Thus, making the foods product damaging to spoilage microorganisms is obligatory to enhance meals safety in growing countries.

### **Biological parameters**

A growing quantity of customers want minimally processed ingredients, organized in the absence of chemical preservatives. Many of those ready to eat devour and novel foods sorts constitute new meals structures with appreciate to fitness dangers and spoilage association. Against this background, and counting on progressed know how and understanding of the complexity of microbial interactions, current tactics are an increasing number of directed in the direction of the opportunities furnished through organic renovation (Nrneborg *et al.*, 2000). In the mild of the above in addition to progressed know how and understanding of the complicated microbial interactions, there may be an expanded tendency to apply bio preservative in the shape of preservative culture or their metabolites which can be enzymes and bacteriocins (Holzapfel *et al.*, 1995). The organic renovation of ingredients can also additionally make contributions to their fitness advantages, for example, acidophilus milk; such probiotic cultures had been taken into consideration secure and offer sizeable fitness advantages to men (Adams, 1999). Lactic acid microorganism produces special antimicrobials along with lactic acid, acetic acid hydrogen peroxide, carbon dioxide, and bacteriocins, which could inhibit pathogenic and spoilage microorganisms, extending the shelf existence and improving the protection of meals products (Aymerich *et al.*, 2000).

**Table.1** Water activity at different concentrations of sodium chloride and sucrose at 25<sup>0</sup> C. produced from Christian (2000).

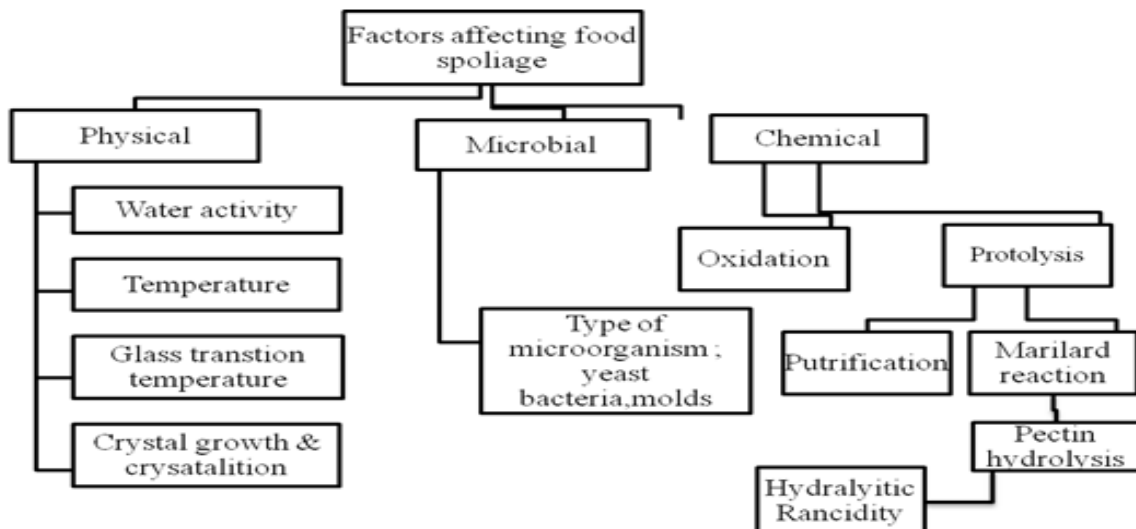
Wa	Nacl (%; w/w)	Sucrose (% w/w)
1.00	0	0
0.98	1.73	15.47
0.97	3.42	26.09
0.96	6.56	39.68
0.93	9.37	48.26
0.91	11.91	54.39
0.90	14.17	58.49
0.87	16.27	62.78
0.86	18.16	65.66
0.83	19.92	
0.81	21.56	
0.80	23.11	
0.76	26.7	

**Table.2** The water hobby limits for boom of main meals-borne pathogens.

Microorganisms	Minimal aw for boom	Reference
Salmonella	0.94	Christian & Scott(2003)
Clostridium botulinum	0.97	Scott (2007),
Clostridium perfringens	0.96	Kang, et al. (2009),
Staphylococcus aureus	0.87	Scott (2007),
Vibrio parahaemolyticus	0.98	Beuchat (2004)

Troller and Stinson (2005) have indicated which minimum water hobby for toxin generating is more than that for boom (0.93) of their examination.

**Fig.1** Factor that affecting food spoilage; physical, microbial, and chemical



## Lactic acid micro-organism

They are a set of gram-wonderful microorganism connected to a constellation of morphological, metabolic, and physiological characteristics. They are covered with inside the organization of non-spores, forming, non-breathing cocci or rods; non-cardio however aerotolerant, acid tolerant, and strictly fermentative with lactic acid because the primary quit product at some stage in the fermentation of carbohydrates. They had been remoted from grains, inexperienced plants, diary and meat products, fermenting veggies and mucosal surfaces of animals (Lindgren *et al.*, 1990).

## Bacteriocins

They are ribosomally synthesized, extracellular launched bioactive peptides or peptide complexes, having bactericidal or bacteriostatic activity. Some bacteriocins however, passed off to kills capability foods -borne pathogens which include *Clostridium botulinum*, *Listeria monocytogenes*, *Staphylococcus aureus*, and bacillus species (Cleveland *et al.*, 2001). Nisin is a great regarded having normally appeared as secure popularity to be used as a right away human meals aspect and has a huge inhibitory spectrum towards gram-wonderful microorganism which include many pathogens and might save you outgrowth of Bacillus and Clostridium spores. Biological renovation techniques can also additionally revel in higher purchaser recognition than their renovation opposite numbers that use conventional chemical preservatives. The kind of product along with intrinsic in addition to extrinsic parameters current at some stage in processing, storage, and distribution will decide the precise technique of organic renovation required. Bacteriocin generating LAB has capability for the renovation of ingredients of plant origin, particularly minimally processed veggies along with prepackaged combined salads and fermented ones (Viscovo *et al.*, 1995).

## Food protection in Ethiopia

It may appear paradoxical to talk about with regards to meals protection while tens of thousands are stricken by loss of foods and of the maximum inferior excellent. At a country wide degree however, each meals scarcity and absence of suitable meals protection guarantee structures are trouble which have grown to be boundaries to the Ethiopian monetary improvement and public fitness protection (WHO,2007). Exports of products in Ethiopian are best approximately seven percentage of

GDP, as compared to a means of close to 30% of GDP IN Sub-Saharan Africa. Export tiers nevertheless fall brief of what is registered through different Africa nations with plenty smaller populations Uganda and Tanzania each export extra than \$ three billion according to year, and exports according to individual stay very low; best \$24 in Ethiopia as compared to \$ two hundred in Sub Saharan Africa and \$580 in growing Asia. Growth costs also are very modest if one makes an evaluation with Asian nations over a decades-long term frame. For example, Ethiopia's general exports had been better than that of Vietnam with inside the Nineteen Eighties however at the moment are only a tiny fraction: \$2 billion in Ethiopia versus \$sixty-five billion in Vietnam (ACREEP, 2010). The excellent and requirements authority of Ethiopia is the country wide requirements frame of Ethiopia installed in 1970. The Authority, that is beneath Neath the Ministry of Science and Technology. The Authority is remitted to make sure meals protection thru certification, inspection and checking out (Rekeying, 2010).

The interaction among the above indexed elements sooner or later determines the boom of a microorganism in a given meals product. Often, the outcomes of such interaction are unpredictable, as poorly understand synergism or antagonism might also additionally occur. Traditional meals renovation strategies have used mixtures of pH, aw, atmosphere, and different inhibitory elements. Microbiologists have frequently noted this phenomenon as the hurdle impact. For example, positive processed meals primarily based totally product might also additionally use the salt to moisture ratio to manipulate meals spoilage. USDA acknowledges this approach in designating shelf solid semi dry sausages with a moisture protein ratio of much less than or same to three 1:1 and pH much less than or same to 5.0. It is the interplay of those elements that controls the cap potential of pathogens to proliferate in food products. Despite this long status reputation of the idea of hurdle technology the feasible synergistic impact of mixing extraordinary inhibitory elements, the modern definition of doubtlessly dangerous ingredients best considers pH and aw independently and does now no longer cope with their interplay. Models that cope with the interplay of different elements for example, atmosphere, preservatives had been posted however aren't almost as severe as fashions the usage of pH and aw. Individual corporations have shown, however, that in-residence fashions incorporating preservative results may be beneficial equipment in lowering the want for great mission checking out and assessing risk. However, a

well-known version for ingredients to control all interactions of atmospheric gases and/or preservative mixtures with pH and aw does not now no longer presently exist. To layout powerful mixtures of elements, understandings of the pathogen (vegetative or spore-forming) and of the mechanisms through which character elements exert their effect are necessary.

## References

- Abdulmumeen, H. A. Ahmed, N. R. Agboola, R. S. 2012. Food: its preservatives, additives and applications. *Int. J. Chem. Biochem. Sci.* 1, 36-47
- Access Capital Research Ethiopia's export performance, 2010
- Adams, M. R. 1999. safety of industrial lactic acid bacteria *J biotechnol*,
- Aymerich, M. T. Gargia, M. 2000. Mon fort bacteriocin reproducing bacteria.
- Bae, J. H. Miller, K. J. 1992. Identification of two proline transport systems in *Staphylococcus aureus* and their possible roles in osmoregulation. *Appl. Environ. Microbiol.* 58 (2), 471-475.
- Beecher, D. J. Lee, A. C. 1994. Identification and analysis of the antigens detected by two commercial *Bacillus cereus* diarrheal enterotoxin immunoassay kits.
- Blackburn, C de W. 2006. Food Spoilage Microorganisms. Woodhead
- Burkepile, D. E. Parker, J. D. Woodson, C. B. Mills, H. J. 2006. Kubanek J/Sobecky P A, and Hay M E. Chemically mediated competition between microbes and animals: microbes as consumers in food webs. *Ecology* 87:2821–2831.
- Christian, J. H. B. 1963. Water activity and the growth of microorganisms. In *Recent Advances in Food Science*, ed. J.M. Leitch and D.N. Rhodes
- Cleveland, J. Montiville, T. J Nes, I. F and Chikindas, M. L. 2001. bacteriocins: safe natural antimicrobials for food preservation
- Damalas, C. A. Eleftherohorinos, I. G. 2011. Pesticide exposure, safety issues, and risk assessment indicators. *Int. J. Environ. Res. Public Health* 8, 1402-1419.
- David, R. J. Jaako, M. Katie, A. M. 2012. The importance of food. *Arch. Pediatr. Adolesc. Med.* 166 (2), 187-188
- Edima, H. C. Tofaig, J. T. Ngoune, L. T. Doune, R. 2012. Assessment of antibiotic residues in cow milk produced in Ngaoundere. *Int J Biol Pharm Allied Sc* 1(11):1530–8.
- Erkyihun, T. 2010. The role of Quality and Standards Authority of Ethiopia (QSAE) in ensuring food safety.
- FAO/WHO 2007. Joint FAO/WHO food standards programmer FAO/WHO coordinating committee for Africa, seventeenth session, Rabat, Morocco, 23-26.
- Forsythe, S., 2010. *The Microbiology of Safe Food*. Blackwell Publishing Limited. p. 320
- Franco, R. Lia, S. Rodriguez-Rocha, H. Burns, M. Panayiotidis, M. I. 2010. Molecular mechanisms of pesticide induced neurotoxicity: relevance to Parkinson's disease. *Chem. Biol. Interact.* 188 (2), 289-300
- Gonzalez, M. Soloneski, S. Reigosa, M. A. Larramendy, M. L. 2005. Genotoxicity of the herbicide 2,4-dichlorophenoxyacetic acid and a commercial formulation, 2,4-dichlorophenoxyacetic acid dimethylamine salt. I. Evaluation of DNA damage and cytogenetic endpoints in Chinese Hamster ovary (CHO) cells. *Toxicology*
- Hobbs, B. C. 1983. *Clostridium perfringens* food poisoning. In: Rechcigl Jr., M. (Ed.), *Handbook of Foodborne Diseases of Biological Origin*. CRC Press, Boca Raton, FL, p. 295.
- Holzappel, W. H. Giesen, Rand. Schillinger, U. 1995. biological preservation of foods with reference to protective cultures bacteriocins and food grade enzymes.
- Hussein, A. Odumeru, J. A. Ayanbadejo, T. Faulkner, H. McNab, W. B. Hager, H. Szijarto, L. 2000. Effects of processing and packaging on vitamin C and p-carotene content of ready-to-use (RTU) vegetables. *Food Res. Intl.* 38, 131-136.
- Jones, J. M., 1993. *Food Safety*. Eagan Press, St. Paul, MN
- LGram, L. Ravn, M. Rasch, J. B. Bruhn, A. B. Christensen and M. Givskov. 2002. *Int. J. Food Microbiol.*
- Lee, S. K. Kader, A. A. 2000. Preharvest and postharvest factors influencing vitamin C content of horticultural crops.
- Lindgren, S. W and Dobrogosz, W. J. 1990. Antagonistic activities of lactic acid bacteria in food and feed fermentations.
- Morris, E. O. 1962. Effect of environment on microorganisms. In *Recent Advances in Food Science*, ed. Hawthorn and J.M
- Mossel, D. A. A. 1983. Essentials and perspectives of the microbial ecology of foods, pp. 1-45 In *Food*



- Microbiology: Advances and Prospects, T.A. Roberts and F.A. Skinner(eds.)
- Nrneborg, L. Jespersen and M. Jakobsen. Arch. 2000. Microbial.
- Nwanekezi, E. C. Onyeali, N. O. 2005. Effect of chemical preservation on the shelf life of bottled intermediate moisture tomato paste stored at ambient temperature.
- OIE. 1997. Scientific and Technical Review Volume 16(2), Contamination of Animal Products: Prevention and Risks for Public Health.
- Pal, M. 2014. Preservation of various foods. Ph.D. Lecture Note, Addis Ababa University, College of Veterinary Medicine and Agriculture, Debre Zeit, Ethiopia.
- Pitt J I and Hocking A D. 1997. Fungi and Food Spoilage. Blackie Academic and Professional, New York.
- Raj, D. Subanna, vie. Ahlawat, O. P. Gupta, P. Hudder, A. G. 2006. Effect of pre-treatments on the quality characteristics of dehydrated food products during storage.
- Ram, S., Bajpai, P., Singh, R. L., Shanker, R., 2009. Surface water of a perennial river exhibits multi-antimicrobial resistant Shiga toxin and enterotoxin producing Escherichia coli. Ecotoxicology. Environ. Safety 72 (2), 490-495
- Ribeiro, G., Santos, D., 2013. Recompensas alimentar I: mecanismos evolucionados e implosion ~es are a obesities. Revista Portuguesa de Endocrinological. Diabetes Metab.
- Sakaguchi, G. Ohishi, I. Kosaki, S. 1988. Botulism structure and chemistry of botulinum. In: Hardegree, M. C., Tu, A. T. (Eds.), Handbook of Natural Toxins, Vol. 4: Bacterial Toxins. Marcel Dekker, New York.
- Scallan, E. Hoekstra, R. M. Angulo, F. J. Tauxe, R. V. Widdowson, M. A. Roy, S. L. *et al.*, 2011. Foodborne illness required in the United States major pathogen. Emerg. Infect. Dis. 17 (1), 7-15.
- Shim, S. M. Seo, S. H. Lee, Y. Moon, G. I. Kim, M. S. Park, J. H. 2011. Consumers knowledge and safety perceptions of food additives: evaluation on the effectiveness of transmitting information on preservatives. Food Control. 22 (7), 1054-1060.
- Sims, R. 1., Fioriti, 1. A. (1977) Menthol as vegetable for oil. 1. Am. Oil Chern.
- Tanaka, N., Traisman, E., Plantong, P., Finn, L., Flom, W., Meskey, L., Guggisberg, J. 1996. Evaluation of factors involved in ant botulinal properties of pasteurized process cheese spreads.
- Vescovo, M. Orsi, C. Scholarism, G. and Toriani, S. 1995. Inhibitory effect of selected lactic acid bacteria on microflora associated with ready to use vegetables.
- Wendafrash, A. 2010. Food safety and codex activities in Ethiopia, Food-borne diseases December 14-15, 2010 Addis Ababa 21-26
- WHO/FAO, 2005. Practical actions to promote food safety. Regional Conference on food safety for Africa. Harare, Zimbabwe, 3-6 October.
- Williams, R. D. 1991. FDA helps prevent spread of cholera epidemic to U.S., FDA consumer, 9, 14. In: Morello, J. A., Domer, J. E. (Eds.), Abstracts of the 90th Annual Meeting of the American Society for Microbiology. Annual Meeting Program Committee, Washington, DC.
- Young, L. L. Reviere, R. D. Cole, A.B. 1998. Fresh red meats: a place to apply modified atmospheres. Food Technol. 42, 65
- Zhu, M. J. Mendonca, A. Ismail, H. A. Du, M. Lee, E. J., Ahn, D. U. 2005. Impact of antimicrobial ingredients and irradiation on the survival of *Listeria monocytogenes* and the quality of ready-to-eat turkey ham.

**How to cite this article:**

Kebede Dida Ariti and Kedir kebero. 2022. Review on Factors that Influencing Microbial Growth in Food Spoilage. *Int.J.Curr.Res.Aca.Rev.* 10(07), 1676-175. doi: <https://doi.org/10.20546/ijcrar.2022.1007.009>