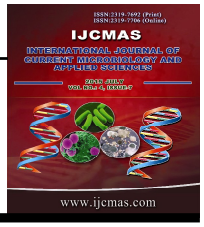
Int.J.Curr.Microbiol.App.Sci (2015) 4(7): 802-809

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 7 (2015) pp. 8020-809**
http://www.ijcmas.com



Review Article

Hurdle Technology-An Approach towards Food Preservation

Aditya Pundhir[1]* and Nida Murtaza[2]

[1]Department of Biotechnology, Shobhit University, Meerut, India
[2]Centre for Agri-informatics, Shobhit University, Meerut, India
**Corresponding author*

A B S T R A C T

K e y w o r d s

Hurdles, Hurdle effect, Hurdle technology, microbial safety and stability, food preservation

In recent years, food preservation and food security have become an important factor of concern. In modern era of food processing, the demand for fresh & good quality food products has led to the emergence of hurdle technology. Hurdle technology is an efficient technique for improving the quality of food and to enhance its shelf life.The main objective of this technology is food preservation, storage of food products and enhancement of their shelf life thereby giving us good quality products.In the present contribution a brief introduction is given about hurdle technology, its aspects and widespread applications in different food products for their efficient preservation.

Introduction

Due to the inadequate technologies for post harvested food preservation more than 50% of the harvested food is often lost due to spoilage in developing countries. It has been reported by FAO of United Nations that one third of the total harvested food of the world is lost before it is consumed. The current consumer demands natural & fresh food which urges the food manufacturers to establish a new preservation technique (Leistner and Gorris, 1995). Statistics shows that 95% of the investment for agriculture resources has been allocated for production while only 5% for the preservation of food. In the majority of the cases microorganisms are responsible for the spoilage or poisoning. Despite the availability of a range of preservation techniques like freezing, blanching, pasteurization, canning etc. spoilage and poisoning of food materials by microorganisms is still a major cause for food spoilage. The microbial safety & stability of most foods are based on an application of preservation factors called as hurdles & the technique applying the different hurdles is known as hurdle technology.

Hurdle technology is a concept that was developed to address the consumer demand for more natural and fresh foods. (Leistner, 2000) defined 'hurdle technology' as an intelligent combination of hurdles which secures the microbial safety and stability as well as retains the organoleptic, nutritional quality and economic viability of food products.

Some of the hurdles such as temperature (high or low), water activity(a_w), preservatives (nitrite, sorbate), competitive microorganisms (lactic acid bacteria) and acidity (pH) have been empirically used for years to stabilize meat, fish, milk and vegetables (Leistner, 2000).Various novel hurdles that are being applied in various food products includes nano-thermo-sonication, ultrahigh pressure, photodynamic inactivation, modified atmosphere packaging of both non-respiring and respiring products, edible coatings, ethanol, milliard reaction products (Gayán et al., 2012). The basic concept is to apply combinations of existing and novel preservation techniques ("hurdles") in order to eliminate the growth of micro-organisms. Therefore, while the aim of effective food preservation is to control all forms of quality deterioration, the overriding priority is always to minimize the potential for the occurrence and growth of food spoilage and food poisoning microorganisms.

Hurdle technology has been developed to reduce the usage of preservatives in foods, and consists of the combined effect of hurdles to establish an additional antimicrobial effect, thus improving the quality of the food (Leistner, 1985).This modern preservation technology has been developed for the consumers who demands healthy and fresh foods that retains its nutritional and organoleptic properties as well.

Aspects of hurdle technology

The hurdle technology affects the physiology and growth of microorganisms in food. There are mainly 4 major mechanisms by which hurdle technology affects the growth of microorganisms in foods:

Homeostasis: It is the process that maintains the stability of the living cell's internal environment in response to the changes in external environment. Some of the examples of homeostasis in the body are regulation of temperature and balance between acidity and alkalinity (pH). These factors are prerequisite feature of living cells and this applies to higher organisms as well as microorganisms (Leistner, 2000). The concept behind homeostasis is already known in higher organisms but this knowledge should be incorporated in microorganisms important for the poisoning and spoilage of foods (Leistner, 2000). Disturbing the homeostasis of the microorganisms by various hurdles eventually results in the death of the spoilage causing microbes thereby protecting the food product from microbial spoilage.

Metabolic exhaustion: This aspect of hurdle technology deals with auto sterilization of food. This was firstly observed in the experiment carried out on liver sausages inoculated with *Clostridium sporogens* and stored at 37^0C (Leistner *et al*, 1970). Later this behaviour of some bacterial spores was regularly observed in shelf stable meat products during storage time period (Leistner, 1994b). It has been observed that the spore counts in hurdle technology treated food products actually decreases during storage especially at ambient temperature. The microbes in the hurdle treated stable products uses their energy for homeostasis thereby becoming metabolically exhausted. This leads to auto sterilization of food products. Thus, the microbiologically stable product becomes safer for storage at normal room temperatures.

Stress reactions: Some microbes acquire resistance or may become more virulent under stress conditions as they synthesize stress shock proteins. The synthesis of stress shock protein is affected by several factors like pH, water activity, ethanol, heat, etc. The different responses of microbes under stress conditions might hamper the food preservation.Exposure to multiple stresses simultaneously activates the energy utilising synthesis of several stress shock proteins, in turn making the microbes metabolically weak. Therefore, multitarget preservation of foods could be an efficient approachtowards reducing the synthesis of stress shock proteins and in food preservation. (Leistner, 2000).

Multitarget preservation of food: It is a very important aspect for efficient and effective preservation of targeted food material (Lesitner, 1995b). Hurdles applied in the targeted food material might not just have effects on microbial stability but they could act synergistically (Leistner, 1978).Synergistic effect could be achieved in the targeted food, if the hurdles affects different targets such as pH, aw, Eh, enzyme systems simultaneously within the microbial cell and thus disturb the homeostasis of the microbes rendering it difficult for the microbes to synthesise different stress shock proteins and to maintain their homeostasis (Leistner, 1995a). Therefore the application of several hurdles simultaneously would lead to an optimal microbial stability and effective food preservation (Leistner, 1994a).

Applications of Hurdle Technology in different products:

Hurdle Technology is a novel concept which has several applications in the preservation of various food products such as:

Dairy products: Hurdle technology has been applied in many dairy products to enhance their shelf life. Shelf stable paneer can be prepared by applying various hurdles such as pH, aw, preservatives and Modified Atmosphere Packaging (MAP. The quality and shelf life of hurdle treated paneer extended from one to twelvedays at ambient temperature and six to twenty days at refrigeration temperature without affecting its physicochemical and sensory properties (Thippeswamy et al., 2011).

In another study, the shelf life of paneer curry was increased using hurdle technology. The product has been treated with certain modified control hurdles like aw, pH and preservatives. The hurdle treated paneer was found to have better quality than heat sterilized product (Rao and Patil, 1999).

Another product ‘brown peda’, a traditional Indian heat desiccated milk khoa based product have also been prepared and preserved through hurdle technology. (Panjagari et al, 2007) studied the effect of conventional cardboard boxes, modified packaging and vacuum packaging techniques on the sensory, physico-chemical, biochemical, textural and microbiological characteristics of brown peda during its storage for forty days at 30ºC and observed a stable shelf life due to low moisture content, higher amount of sugar and severe heat treatment applied during its preparation. Hurdle treated ‘brown peda’ could be best preserved up to forty days at room temperature (30±1ºC) without any quality loss (Panjagari et al, 2007).

Fruits & Vegetables: Several hurdles are considered to be important in the

preservation of various vegetables and fruits like carrot, pineapple, coconut & papaya to enhance their stability and shelf life.

Shelf-stable grated carrot products are developed using hurdle technology. (Vibhakara et al., 2006) used several hurdles such as antimicrobials, partial dehydration and packaging in polymeric bags to develop grated carrotsthat can remain fresh and microbiologically safe for more than six months at ambient temperature.

Hurdle technology can also be applied to develop shelf stable RTE (Ready-To-Eat) intermediate moisture pineapple with increased shelf life. Osmotic dehydration, infrared drying and gamma radiation can successfully reduce the microbial load in pineapple slices increasing its shelf life up to 40 days (Saxena et al., 2009).

(Gunathilake, 2005) applied hurdle technology in the preservation of fresh scrapped coconut. Additives such as humectants, acidulants and preservatives were used. The shelf life of hurdle treated coconut gratings was increased by one month at ambient temperature and by three months at refrigerated temperature (5+2˚C).

Minimally processed shelf stable high moisture grated papaya is also prepared by hurdle technology using different hurdles like mild heat treatment, aw, pH reduction, and the addition of preservatives(López-Malo et al., 1994). This 'combined methods technology' developed microbiologically safe and nutritionally intact papaya that is shelf stable at ambient temperature for more than five months.

Fruit derived products: Several conventional hurdle strategies are effectively used along with the novel ones for the preservation of various fruit products. Some of the hurdles applied in fruit processing includes UV light, pulsed light (PL), ultrasound (US), and high hydrostatic pressure (HHP) (Gomez et al, 2011).

(Sankhla et al., 2012) preserved sugarcane juice by using several potential hurdles like heat treatment, preservatives, irradiation and various packaging materials. The applicability of these hurdles shows great enhancement in the level of product safety and stability and thus it can therefore be recommended for preservation of all kinds of food material (Sankhla et al., 2012).

Hurdle or combined technology is also applied in the preservation of high moisture fruit products such as peach, pineapple, papaya, mango and banana. The technology is based on the combination of heat treatment, a_w and addition of antimicrobials (Alzamora et al., 1993).

In Meat & Meat products: Hurdle technology has been applied to a number of meat products. Thomas et al., 2010 studied the effect of different hurdles such as (pH, a_w, vacuum packaging and post package treatment) in pork sausages at refrigerated temperature. The combined effect of these hurdles on pork sausages resulted in the inhibition of the growth of yeast and molds up to 12 days, while the dipping of sausages into potassium sorbate solution before packaging inhibited their growth up to 30 days. Implementation of hurdle technology into sausages was beneficial as the shelf life of sausages was increased up to 30 days while the control untreated samples were acceptable up to 18 days(Thomas et al., 2010).

Shelf stable ready to eat pickle type spiced buffalo meat products was also prepared and preserved by controlling different hurdles like pH, water activity, proximate composition, FFA, Soluble hydroxyproline, TBA values, nitrite content, protein

solubility (Malik and Sharma, 2014). Hurdle Technology has made it possible to deliver shelf stable and ready to eat meat products for space scientists and mountaineers.

Figure.1 Most Common hurdles for food preservation

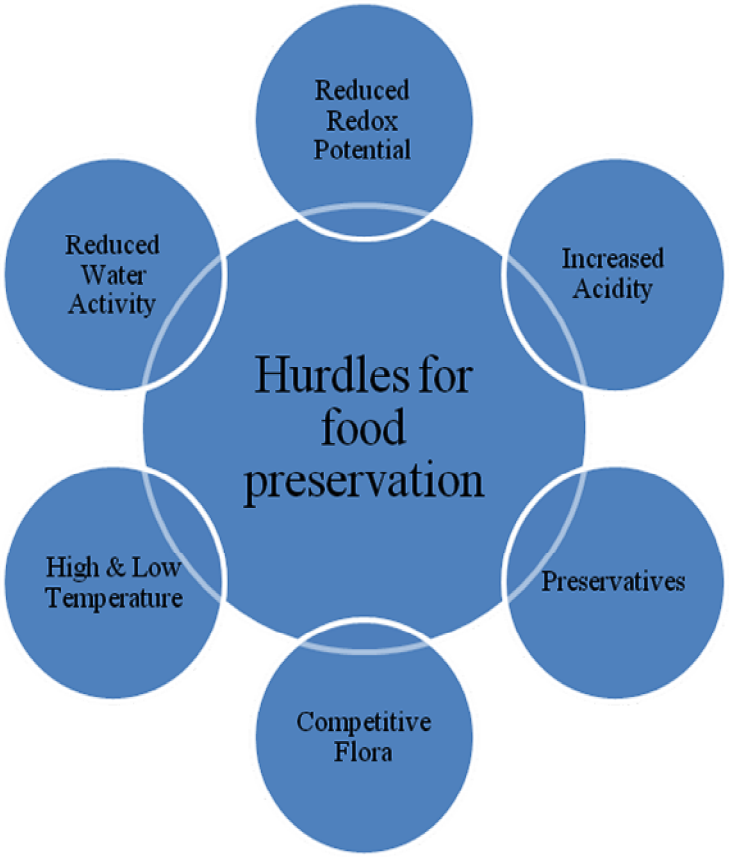


Figure.2 Basic aspects behind the concept of hurdle technology

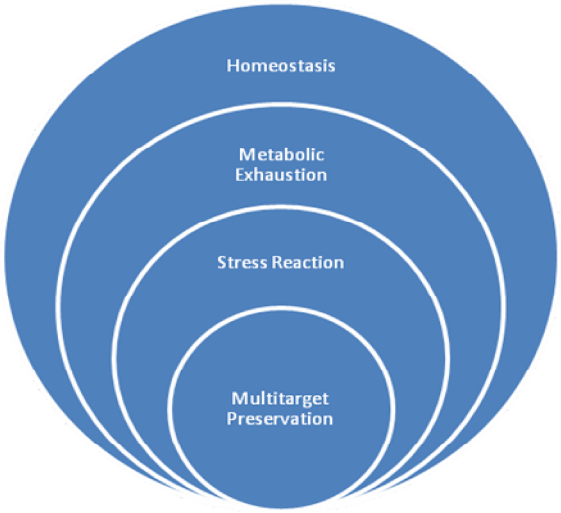
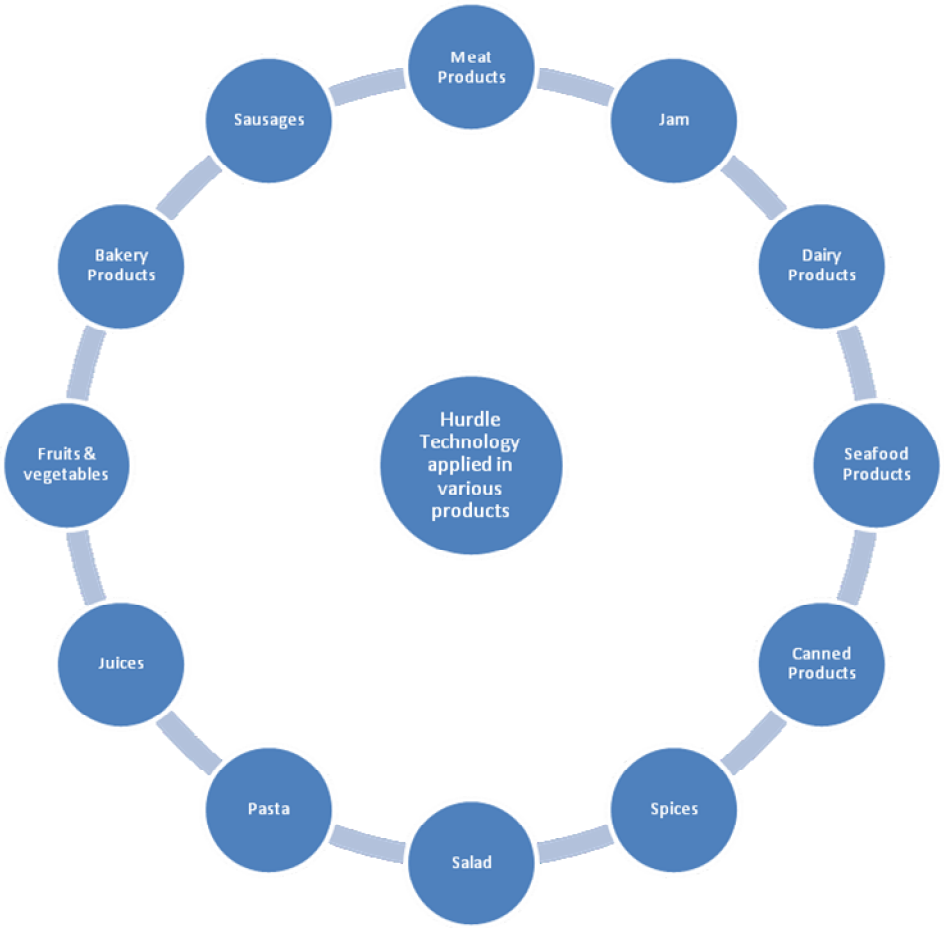


Figure.3 Hurdle technology applied in various products



Karthikeyan et al., 2000 applied hurdle technology for the production of shelf stable caprine *keema* stable at ambient temperature. The hurdles used by them were

$a_{w,}$ pH vacuum packaging, heat treatment and preservatives. The hurdle treated *keema* was shelf stable and accepted up to the fifth day unlike the conventionally prepared *keema* that is highly perishable and is accepted only until the first day.

Several hurdles such as marination, cooking and glycerol have been applied in the production of shelf stable chicken lollipop (Singh et al., 2014).

With the growing economy there is an increased demand for fresh and minimally processed food products. Conventional fruit preservation methods are based on single preservation parameter that makes changes in the sensory and nutritional quality of the fruit. The hurdle technology makes minimal sensory and nutritional changes in the product which makes the product more valuable and acceptable than obtained by conventional methods and has become a boon for the efficient preservation of food products.

References

Alzamora, S.M., Tapia, M.S., Argaíz, A., Welli, J., 1993. Application of Combined Methods Technology in Minimally Processed Fruits. Food Res. Int. 26, 125–130. Doi: 10.1016/0963-9969(93)90068-T

Gunathilake K.D.P.P., 2006, Application of hurdle techniques to preserve fresh scraped coconut at ambient and refrigerated storage, J. Natn. Sci. Foundation Sri Lanka, 33(4), 265-268

Gayán, E., Torres, J.A., Paredes-Sabja, D., 2012. Hurdle Approach to Increase the Microbial Inactivation by High Pressure Processing: Effect of Essential Oils. Food Eng. Rev. 4, 141–148. Doi: 10.1007/S12393-012-9055-Y

Karthikeyan, J., Kumar, S., Anjaneyulu, A.S.R., Rao, K.H., 2000. Application of Hurdle Technology for the Development of Caprine *Keema* and Its Stability at Ambient Temperature. Meat Sci. 54, 9–15. Doi: 10.1016/S0309-1740(99)00053-4

Leistner, L., 1978. Hurdle effect and energy saving. In: Downey, W.K. (Ed.), Food Quality and Nutrition, Applied Science Publishers, London, UK, pp. 553–557.

Leistner, L., 1985. Hurdle technology applied to meat products of the shelf stable product and intermediate moisture food types. In: Simatos, D., Multon, J.L. (Eds.), Properties of Water inFoods in Relation to Quality and Stability, MartinusNijhoff, Publishers, Dordrecht, Netherlands, pp. 309–329.

Leistner, L., 1994a. Further developments in the utilization of hurdle technology for food preservation. J Food Eng 22, 421–432.

Leistner, L., 1994b. Food Design by Hurdle Technology and HACCP, Printed and distributed by the Adalbert-Raps-Foundation, Kulmbach, Germany, p. 62

Leistner, L., Gorris, L.G.M., 1995. Food Preservation by Hurdle Technology. Trends Food Sci. Technol. 6, 41–46. Doi: 10.1016/S0924-2244(00)88941-4

Leistner, L., 1995a. Principles and applications of hurdle technology. In: Gould, G.W. (Ed.), New Methods for Food Preservation, Blackie Academic and Professional, London, pp. 1–21

Leistner, L., 1995b. Emerging concepts for food safety. In: 41st International

Congress of Meat Science and Technology, 20–25 August 1995, San Antonio, Texas, pp. 321–322.

Leistner, L., 2000. Basic Aspects of Food Preservation by Hurdle Technology. Int. J. Food Microbiol. 55, 181–186. Doi: 10.1016/S0168-1605(00)00161-6

López-Malo, A., Palou, E., Welti, J., Corte, P., Argaiz, A., 1994. Shelf-Stable High Moisture Papaya Minimally Processed By Combined Methods. Food Res. Int. 27, 545–553. Doi: 10.1016/0963-9969(94)90140-6

Malik, A.H., Sharma, B.D., 2014. Shelf Life Study Of Hurdle Treated Ready-To-Eat Spiced Buffalo Meat Product Stored At 30□±□3 °C For 7 Weeks Under Vacuum And Aerobic Packaging. J. Food Sci. Technol. 51, 832–844. Doi: 10.1007/S13197-011-0592-9

Paula Luisina Gómez, Jorge Welti-Chanes, and Stella Maris Alzamora**, 2011,** Hurdle Technology in Fruit Processing**,**Annual Review of Food Science and Technology,Vol. 2: 447-465. DOI: 10.1146/annurev-food-022510-133619

Panjagari, NR., Londhe, GK. , Pal, D., 2007. Effect of packaging techniques on self-life of brown peda, a milk based confection, J. Food Sci and Tech. 47, 117-125

Rao, KJ., Patil, GR., 1999. Development of ready to eat paneer curry by hurdle technology. J Food Sci Tech. 36, 37-41

Sankhla, S., Chaturvedi, A., Kuna, A., Dhanlakshmi, K., 2012. Preservation of Sugarcane Juice Using Hurdle Technology. Sugar Tech 14, 26–39. Doi: 10.1007/S12355-011-0127-8

Saxena, S., Mishra, B.B., Chander, R., Sharma, A., 2009. Shelf Stable Intermediate Moisture Pineapple (AnanasComosus) Slices Using Hurdle Technology. LWT - Food Sci. Technol. 42, 1681–1687. Doi:10.1016/J.Lwt.2009.05.009

Thippeswamy, L., Venkateshaiah, B.V., Patil, S., 2011. Effect of Modified Atmospheric Packaging on the Shelf Stability of Paneer Prepared By Adopting Hurdle Technology. J. Food Sci. Technol. 48, 230–235. Doi:10.1007/S13197-010-0155-5

Thomas, R., Anjaneyulu, A.S.R., Kondaiah, N., 2010. Quality of Hurdle Treated Pork Sausages during Refrigerated (4 ± 1°C) Storage. J. Food Sci. Technol. 47, 266–272. Doi:10.1007/S13197-010-0041-1

Veer Pal Singh, Vikas Pathak, Narendra Kumar Nayak and MeenaGoswami, 2014, Application of hurdle concept in development and shelf life enhancement of chicken lollipop, Int.J.Curr.Microbiol.App.Sci(2014)3 (1): 355-361

Vibhakara, H.S.J., Gupta, D.K.D., Jayaraman, K.S., Mohan, M.S., 2006. Development of a High-Moisture Shelf-Stable Grated Carrot Product Using Hurdle Technology. J. Food Process. Preserv. 30, 134–144. doi:10.1111/j.1745-4549.2006.00055.x