

Hurdle Technology- Multitarget preservation approach in pandemic

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Abstract— Covid-19 has brought the world to its knees. Businesses are shut, schools and colleges are closed, traveling is banned. To conclude the world is in virtual halt. Its complete opposite is true for the food industries, which are operating day and night to meet the demand of world in isolation. The spread of virus has brought countless significant changes in our lifestyle. From the drastic changes in personal hygienic practices to the boost in demand of online classes for kids to work from home. Thus, circuitously affecting our physical and psychological well-being. Apart from all of these changes, the food industry is also experiencing a complete shift in consumer preferences. Demand of more organic foods with better and longer shelf life have increased in these times of pandemic. Buyers uncertain of when would their next trip to grocery stores be and whether they would be able to find any food restocked, chooses the food that could sit on the shelves for months without losing its nutrition value and that could also possibly limit their trip to grocery shops. The impact of the virus is very strong and made people think twice about their preferences and choices of food they consume. The dynamics of food will be changing for a reasonably long time to come. In this article we will be knowing that how combined combination of preservation techniques are gaining attention from past years and is also a novel preservation method in the time of pandemic.

Index Terms—combined methods, covid-19, hurdle effect, hurdle technology

I. INTRODUCTION

Hurdle technology recognized as combined method, combined processes is the technology that uses set of two or more preservation techniques (hurdles) together at an optimum level in order to get maximum result stability in terms of security , taste , quality and nutrients against micro -organisms without compromising with the quality of end food product. This hurdle effect was first illustrated by leinster (1978). There are more than 60 hurdles that may involve together in preservation of food such as heating, drying, freezing pasteurization, sterilization, refrigeration, vacuum etc. hurdle technology is used for multi targeted preservation of food. The right combination of hurdles can ensure the food free from microbes and a better shelf life product which could possibly not be attained with single preservation method. It is just like a hurdle race but between the micro-organisms, the moment the food is harvested growth of undesirable micro-organisms can be seen. So different “hurdles” are provided inhibiting their growth. Due to the emergence of new routes for the growth of micro-organisms, multiple preservation of food is effective way. The principal hurdles used for the preservative factors for ensuring safety in food are temperature (higher or lower), water activity (aW), acidity (pH), redox potential (Eh), chemical preservatives (nitrite, sorbate, sulfite), vacuum packaging, MAP, HHP/HPP, UV, and competitive microorganisms.

II. BASIC PRINCIPLES OF HURDLE TECHNOLOGY

The feasible responses to the hostile environment determine whether the micro-organism may grow or die. There are basic Four principles by which hurdle technology affect the growth of micro-organisms in food.

1. Homeostasis
For successful survival of the cells inside an organism a uniform and stable ecosystem is required. Therefore homeostasis is the tendency to uniformity and stability in the internal status of micro-organisms. To repair disturbed homeostasis condition, high energy is needed, so that the repair mechanism is prevented, which will lead to synergistic effect on preservative factors. Preservation of foods can be done by upsetting the homeostasis of micro-organisms.
2. Metabolic Exhaustion-
Auto-sterilization in food products could be achieved by metabolic exhaustion. which leads to the death of germinated spores and thus ensuring the success of hurdle technology. Micro-organisms in hurdle technology foods try every possible mechanism for their homeostasis by which they end up consuming their whole energy and die leading to auto sterilization of foods.
3. Stress reaction
synthesis of protective stress shock protein is induced by several factors such as water activity, pH, heat, ethanol etc . exposure to multiple stresses can cause organism metabolically weak. Therefore, multi targeted preservation of food can be the key to avoid synthesis of stress shock protein (leister 2000)
4. Multi-target preservation
It is a very important characteristic for efficient and

effective preservation of targeted food material (Leistner, 1995b). Hurdles used in food material not just targets the microbial stability but also acts synergistically (Leistner, 1978). Synergistic effect can be achieved in the foods, by applying hurdles effects such as pH, aw, Eh, enzyme systems simultaneously within the microbial cell.

This disturbs the homeostasis condition of the microbes and making it difficult for the microbes to synthesise different stress shock proteins. Thus inhibiting to uphold their homeostasis (Leistner, 1995a). Hence use of different hurdle combinations leads to an optimal microbial stability and effective food preservation (Leistner, 1994a).

III. DIFFERENT TYPES OF HURDLES

There are three main types of hurdles used for preserving foods. Types of hurdles used effect the quality of food that could be positive or negative depending upon the intensity of hurdle used. objective of hurdle is to inhibit the growth of micro-organisms in food

TYPE OF HURDLE	EXAMPLES
Physical	High temperature , low temperature, ultra – high pressure , ultraviolet radiation , ionizing radiation , packaging films , electromagnetic energy , aseptic packaging etc
Physicochemical	Carbon dioxide, ethanol, lactic acid , low ph , redox potential , low water activity , salt , smoking , spices and herbs , surface treatment agents , phenols , phosphates , ozone etc
Microbially derived	Antibiotics, bacteriocins, competitive flora, protective cultures.

IV. STANDARD HURDLES AND THEIR SYMBOLS

Standard principles are applied for the preservation of many foods, be it in industrialized and even in developing countries, especially in the food industries for its various products. Essential issues, like oxidation of lipids or hindering the internal stability and staus of organisms, are the areas which are

presently being studied. This methodology is valid for quality features of foods also. To safeguard the desired superiority of a food, the use of right hurdles should be applied within the optimal range.

Principal hurdles used for food preservation (after leistung 1955)		
Parameter	Symbol	Applications
High temperature	F	Heating
Low temperature	T	Chilling, freezing
Reduced water activity	aw	Drying, curing, conserving
Increased acidity	pH	Acid addition or formation
Reduced redox potential	E _h	Removal of oxygen or addition of ascorbate
Biopreservatives		Competitive flora such as microbial fermentation
Other preservatives		Sorbates, sulfites, nitrites

(Source Wikipedia)

V. NEED OF HURDLE TECHNOLOGY

1. As the demand for fresh and natural food product never go out from the eye of buyer. And due to this pandemic the demand of fresh and less processed food which can be stored for longer time has increased majorly.
2. The need for minimally processed foods.
3. Emergence of the new routes for the growth of micro-organisms.

VI. APPLICATION OF HURDLE TECHNOLOGY

Simultaneous use of hurdle technology leads to the optimal microbial stability. It is novel concept and is emerging technology in the food preservation. Though its traces can be found from many years back but due to its multiple targeting efficiency it proves to be novel model in these times of pandemics when demand of fresh, natural and minimally processed food products are high. Wide range of combined hurdles are being used in dairy industry, for fresh fruits, vegetables and their derived products, industries dealing with animal products etc. at the present. As various studies have shown various class 2 preservatives adversely affect the health of people. So efforts are made to lower the effect of chemical preservatives by combining it with other preservation technique which proves useful both health and the product shelf life. Proper application of combined methods gives us stable product which, prevents the undesirable side-effects of individual treatments, it also saves energy and cut down the requirement of concentration of preservatives added. (Pokorn, 1994).

Different hurdles at lower concentrations bid more resistance to microbial activities than discrete hurdles used at higher concentrations. Example includes the preservation of jams and jellies. These products are subjected to high heat, low pH (of fruits), low aw (sugar in fruits and added), and anaerobic packaging combination of hurdles which reduces microbic population as well as halt in survivors growth (Bibek, 2005). Therefore, In jam or other fruit preserves, the different hurdles used are heat, high solids content (reduced water activity) and high acidity (Lee, 2004).

3% NaCl (sodium chloride) and 0.3% of citric acid is when added on fresh gratings of coconut extends the shelf life by one month under ambient temperature conditions and by three months' increase of shelf life under refrigeration conditions (Gunathilake, 2006). combination of salt (8%), Citric acid (300ppm), potassium meta-bisulphite (300ppm) and sodium benzoate (300ppm) is the best hurdle treatment for low cost preservation of cauliflower (Jyoti et. al., 2013). This concept increases the shelf life of cauliflower to 180 days when it is stored at temperature between 30- 37°C (near to room temperature).

Shelf life of pineapple fruits slices are being extended with osmotic dehydration. High-density polyethylene used with 1kGy dose of radiation proved to be efficient in increasing its table life for upto four months under room temperature storing conditions (Sujatha, 2014). Different methods to extend the shelf life paneer are studied by researchers as it is delicate product can easy prone to microbial spoilage. One of the treatment involves lowering the aw of paneer by different hurdle methods. Low heat treatment and acidification value increases the storing life of paneer for 14 days at room temperature. Another method involved addition of a percent of sodium chloride, glycerol and sucrose which decreased the water activity of paneer and hence extends its shelf life (Rao and Patil, 1992). Hence stable paneer can be prepared by the combination of various hurdles which includes lowering pH, water activity (aw), use of preservatives. For the packaging MAP method is used.. The quality and shelf life of paneer

with hurdle effect had extend shelf life till twelve days at ambient temperature (35 -40 degree celcius). 6 to 20 days shelf life was seen at refrigeration temperature without upsetting the physicochemical and organoleptic properties of the paneer.(Thippeswamy et al., 2011).

Hurdle technology has been administered to various meat, fish, poultry eatables as well. Researchers noted that the collaborated effect of hurdles such as vacuum encasing, after-encasing care, pH, aw helped in storing the pork sausages upto 12 days from the detrimental effects of yeast and mold growth whilst it can be increased upto 30 days by submerging the sausages in potassium sorbate blend prior to encasing process obstructed the escalation of spoilage causing microbes. Vacuum packaging and post package treatment were also considered. Introduction of this technology in sausages proved to be advantageous since its shelf life reached 30 days whereas the crude sausages were accepted for 18 days only (Thomas et al., 2010). Hence administration of hurdle technology in the meat fish, fish, poultry industry was beneficial for various products. Another researches to extend the shelf life of chicken lollipop using hurdle technology enhanced the shelf life of the product greatly

The shredded papaya which is minimally feigned but rich in moisture is another eatable produced by the use of hurdle technology. Stunted aw, low pH, truncated heat processing with the incorporation of preservatives in controlled amounts favoured in developing microbiologically secure and nutritionally undamaged papaya which has sturdy nature at normal temperature conditions for a time being of 5 months. Preservatives, irradiation and usage of various encasing medium was reported to enhance the shelf life of sugarcane juice. These potential hurdles not only improved the stability of the produce but also marked to be at a better level in context to product safety. Thus there is a noticeable increase in the use of hurdle technology for almost all the food produces.

Combination of thermal inactivation with another non-thermal hurdles takes a special an place among different combined technologies which is highly suggested (Bazhal et al., 2003). Anurag et al., (2013) researched about the application of radiation to intermediate moisture of dried products by infrared, and use of 400-gauge polythene bag which will provide effective retention to the nutrient value up to six months under ambient storage. In zobo (traditional sorrel drink) Ilondu and Iloh reported Drastic growth inhibition of *Aspergillus flavus* and *A. niger* and was treated with spices and subjected to heating after production. Addition of multiple type of preservatives like ascorbic acid, potassium sorbate, and sodium bisulphite into sugar syrup retained the colour of fresh mango slice for a period of 30 days and long Jose et. al. (2008).

Eke et al., (2013) Researches showed that addition of citric acid in dambu-nama (chicken floss) reduced its microbial activity thus increasing the protein activity as well as its shelf life. Microbial balance of the sous vide packaged seasoned beef product was successfully upgraded by the inclusion of vinegar and sake and now could be stored at 8 degree Celsius and 20 degree celcius. This alternative is such which

guarantees slightest deprivation of organoleptic traits in conditions where increased shelf life is needed. (Jae et al., 2006).

Curd rice a very popular and long established diary product of southern part of India, can be stored at an ambient temperature of 30 degree Celsius for a day ordinarily without any preservation. So it was aimed to lengthen the expiry date of the product by using different hurdle effects on it. Boiling the milk after fresh ginger added to it for nearly 1-3 minutes and then the seasoned milk is cooled for the preparation of rice curd. Ginger added to the curd product for 24 hours to 7 days at 37 degree Celsius (room temperature). It was also found for longing the keeping life and quality the product could also be kept at refrigerated storage at 4 to 6 degree Celsius temperature for 12 days of time. The aw and acidity of curd rice were 0.994 and 0.54%. hence Balasubramanyam concluded that natural preservative like ginger is likely a hurdle to lengthen the keeping life of the curd rice (Balasubramanyam et al., 2004).

Hurdle technology is also used to formulate and uphold a traditional indian sweet eatable; i.e. brown peda which is basically a khoa product. Researches were performed to analyse the effect of various encasing techniques such as modified packaging, clicheed cardboard packets, vacuum packaging operations on the sensorial, physio-chemical, compositional, biochemical, microbiological traits of brown peda throughout its storage period of 40 days at a temperature of 30°C. This research remarked that because of its truncated moisture level, elevated quantity of sugar and application of critical heat reception during the process of making the peda, the peda was shelf stable for 40 days at ambient temperature lacking any deprivation in the quality. (Panjagari et al, 2007).

Saxena et al., 2009 viewed a notable increase in the shelf life of RTE intermediate moisture pineapple by the use of right combination of hurdles which included osmotic dehydration along with infrared drying with the help of gamma radiation. As a result the microbial growth in pineapple slices was lessened which hence increased the shelf life for 40 days.

CONCLUSION

Emergence of the new routes for the growth of micro-organisms can be seen in past years. A fresh example to new micro-organism is the spread of corona virus which is a zoonotic disease (transfer of disease from animal to human being) so, new technologies are being discovered by the food technologists, scientist and all the people working for this field to possibly eliminate the growth of micro-organisms or just stop entering and spoiling the food that could adversely affect the health of consumer. Food we eat has to go through a long way from its initial raw products from farm to its processing in industry till it reaches our plate, right after its harvest stage it gets targeted by various micro-organisms which could be dangerous to food as well as the person consuming it. Hence finding new ways is progressive and essential demand for the preserving and processing of food. but looking a step back we can find old yet novel approach for the preservation i.e hurdle technology which targets many

aspects of microorganism and multiple preserving methods protects the product for longer shelf life maintaining its organoleptic, nutritious, healthy, chemical properties. Smart application of hurdles can open wide range of preservation of methods. More than 60 hurdles reported to be available, these can be use in different combinations and concentrations in wide range of foods. Which makes the application of the technology possible both modern and local food processing. Today public concern is toward less damage food product with maximum protection of food to microorganism. So any one preservation technique lead to damage to nutritional value or sensory damage other can balance it. hence hurdle technology is boon for efficient preservation of food products. further researches on aspects of microorganism can prove it more viable until new technologies are yet in progress.

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