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HURDLE TECHNOLOGY IN FOOD SECURITY

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Abstract: -

Food security and preservation have grown to be major concerns in recent years. The need for fresh and high-quality food products in the current era of food processing has given rise to hurdle technology. Hurdle technology is a useful method for extending the shelf life and enhancing food quality. 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. With Hurdle technology, different bacteria-inhibiting or -killing factors are combined (some of the 'hurdles,' e.g., are salt, reduced pH, reduced water activity, heat treatment, and appropriate packaging) to produce a safe product with an acceptable shelf life, acceptable consistency, and an acceptable taste. The basic concept is to apply combinations of existing and novel preservation techniques ("hurdles") in order to eliminate the growth of micro-organisms. 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.

Keywords: *Hurdle technology, food, quality, safety etc.*

INTRODUCTION:

Hurdle technology is an innovative combination of hurdles that work together to produce high-quality, safe, and healthy goods.

Hurdle technology, also known as combination or combined preservation, was created as a more recent idea for nutritious, flavor, affordable and safe food. For centuries,

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combined methods were applied empirically in food preservation. For example, combination treatment includes heat, reduced moisture content and antimicrobial chemicals deposited from the smoke onto the surface of the food. Some smoked foods may also be dipped or soaked in brine or rubbed with salt before smoking to infuse the flesh with salt and thus add a further preservative mechanism. In jam and other fruit preserves, the combined factors are heat, high solids content (reduced water activity) and high acidity. In vegetable fermentation, the desired product quality and microbial stability are achieved by a combination of factors such as salt, acidification and so forth. Thus, preservation is required to increase the amount of time that these foods may be stored while maintaining

Table 1: Literature on hurdle technology

Sl.No.	Hurdle technology types	
	Individuals Hurdlees grouped according to primary function	
1.	Microbiicidal hurdles that reduce microbiological load	Bactofugation, competitive microflora, microfiltration, ripening(ageing), Thermization, high-pressure treatment, Ultrasonification
2.	Microbiostatic hurdles that limit and / or prevent growth by biochemical means	pH, CO_2, Use of preservatives, Modified atmosphere
3.	Microbiostatic hurdles that limit and / or prevent growth by physical means	Refrigeration, Water activity control
4.	Hurdles that prevent contamination	Light. Coating, packaging

Source: tp://ftp.fao.org/codex/meetings/CCFH/CCFH34/AnnexIIP artA

Table 2: Principles hurdles for food preservation

Sl. No.	Parameter	Application
1.	High Temperature	Heating
2.	Low Temperature	Chilling, Freezing
3.	Water Activity	Drying, curing (with added salt), Conserving (With added sugars)
4.	Acidity	Acid addition or formation
5. **6.**	Redox Potential	Removal of oxygen (by vacuum packaging and Nitrogen packaging
7.	Biopreservatives	Competitive flora such as microbial fermentation
8.	Preservatives	Sorbates, Sulfates, Nitrities

Source: Leistner, 1995: Lee, 2004

their nutritional value (Angousana *et al*., 2025). Therefore, hurdle technology is a technique that uses a clever combination of barriers to improve the overall quality of meals (Ohlsson,2002).

HURDLE TECHNOLOGY: IMPORTANT

- ✓ Application of this technology will result in a safe product with enhanced microbiological stability, maximum shelf life and sensory quality
- ✓ Better economic and nutritional qualities.
- ✓ Easy to use, resulting in lower expenses for transit and storage
- ✓ Stable on the shelf at room temperature

MECHANISM OF HURDLE TECHNOLOGY

To preserve food, microbes must be placed in an unfavourable environment that will either stop them from growing or kill them. The ability of microbes to adapt to this harsh environment will decide whether they survive or proliferate.

Table 3: Types of hurdles for food preservation

Sl.No.	Types of hurdles	Examples
1.	Physical	Aseptic packaging. Modified atmosphere packaging, packaging films, ultraviolet radiation
2.	Physicochemical	Ethanol, CO_2, lactic acid, low pH, low redox potential, low water activity
3.	Microbial	Antibiotics, competitive flora
		Source: Ohlsson 1985; Lee 2004

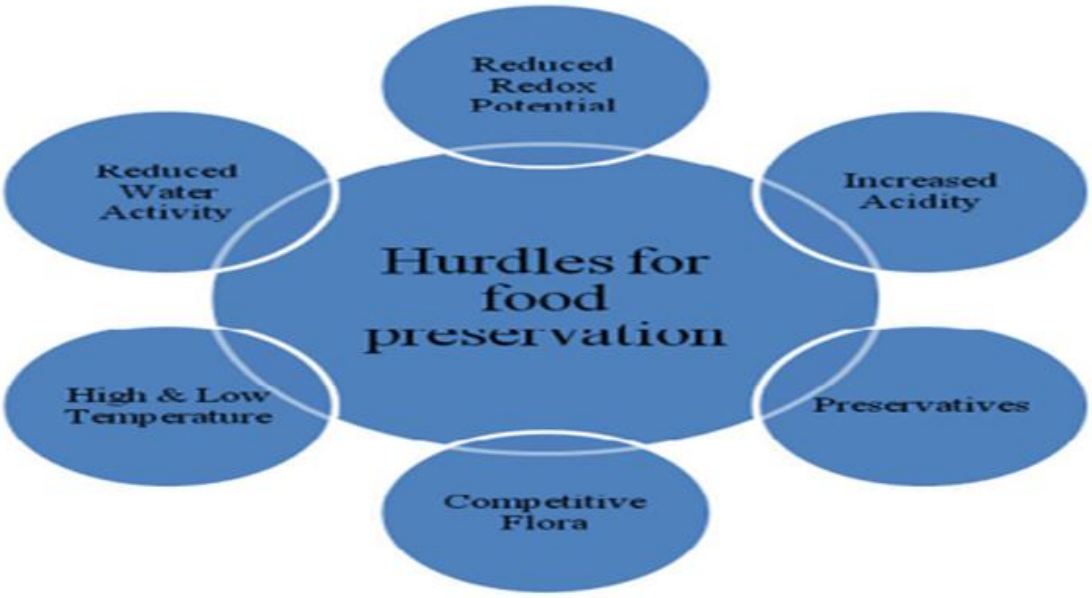

Fig.1: Common hurdles for food preservation

Source: Neeha and Kakade, 2014

The various responses of microorganisms are:

1. Homeostasis

Homeostasis is the tendency to uniformity and stability in the internal status of organisms. If the homeostasis of these microorganisms is disturbed by preservative factors in foods, they will not multiply, i.e. they remain in the lag-phase, before homeostasis is repaired (re-established). The repair of disturbed homeostasis demands much energy of microorganisms, and the restriction of energy supply inhibits the repair mechanisms of microbial cells. The energy restrictions for microorganisms can be caused by applying anaerobic conditions such as MAP or vacuum packaging. Therefore, food preservation can be achieved by disturbing the homeostasis of microorganisms in a food temporarily or permanently (Leistner, 2000).

2. Metabolic Exhaustion

The bacterial spores that survive after the heat treatment are able to germinate under less favorable conditions than those under which the vegetative bacteria are able to multiply. Therefore, when hurdles (less favorable conditions) are created, the vegetative microorganisms can be derived from the germination of bacterial spores. But the vegetative bacteria ca not grow or even die (due to prevailing of less favorable conditions).

They will die more quickly if:

a. The stability is close to the threshold for growth

b. Storage temperature is elevated.

c. Antimicrobial substances are present.

d. The organisms are sub-lethally injured (e.g. by heat).

The vegetative microorganisms will

Table 4: Homeostatic responses to stress by microorganism

Sl.No.	Stress factor	Homeostatic response
1.	Low level of nutrients	Nutrients scavenging: oligotrophy
2.	Lowered pH	Extrusion of protons across the cell membrane, maintenance of cytoplasmic pH
3.	Lowered water activity	Accumulation of compatible solutes, maintenance o membrane turgor
4.	Raised temperature for growth	Heat shock response
5.	Competition from other microorganisms	Formation of interacting; aggregates of cells showing some degree of symbiosis: biofilms

Source: Lee, 2004

to overcome this hostile environment by using their energy. After complete use up of their energy, the microorganisms are metabolically exhausted & they will die automatically due to deficiency of energy. This process is called auto sterilization. Therefore, during storage without refrigeration, some of viable spores germinate, but the vegetative cells deriving from these spores die. Thus, the spore count actually goes on decreasing during storage, & the product becomes even safe during storage especially at ambient temperature

3. Stress Reactions

Under stress, some bacteria become more resistant to heat & become more virulent, due to generation of stress shock proteins. These stress shock proteins help the organism to cope with stress situations. This is the main limitation to the process of hurdle technology & to avoid the synthesis of stress shock proteins, multi target preservation should be applied. The synthesis of these proteins is induced by heat, pH, aw, ethanol & so on, as well as by starvation (Leistner, 2000).

4. Multi-Target Preservation

The switch on of GENES for synthesis of stress shock proteins will become more difficult if various stresses are achieved at the same time. This is because countering with different stresses simultaneously will demand energy, which the microorganisms cannot deliver since they become metabolically exhausted (Leistner, 2000). A synergistic effect could become true if the hurdles in a food hit, at the same time, different targets (e.g. Cell membrane, DNA, enzyme system, pH, aw, Eh) within the microbial cell and disturb the homeostasis of microorganisms present in several respects (Leistner, 2000).

APPLICATION AND SAFETY OF HURDLE TECHNOLOGY

A. Pineapple slices (Saxena *et al* 2009), prepare a shelf stable, ready-to-eat and safe intermediate moisture pineapple slices using hurdle technology. They used a combination of hurdles including potassium metabisulfite dip, osmotic dehydration, infrared drying, polyethylene packaging and a radiation dose of 1 kGy. This combination was found to be effective in extending the shelf life of pineapple slices up to 40 days under ambient storage temperature, whereas the control non-treated slices spoiled within 6 days. The potassium metabisulfite dip was indispensable for browning inhibition. Osmotic dehydration and infrared drying reduced aw, which prevented microbial growth. The radiation dose was found effective in eliminating the residual microbial load on these pineapple samples. Thus ensuring the RTE intermediate moisture pineapple slices as microbiologically safe with good texture,

colour and sensorily accepted throughout storage.

Safety:

1. Pesticides are usually applied to plants to combat insects, plant diseases, and weed growth to assist in the growth of the fruit or vegetable so washing of fruits with water is important.
2. Concentration of KMS solution is should be in safe level for heath of people.
3. Radiation dose should be 1kGy.

B. Pickled fruits and vegetables (Lee, 2004), in his article covers an overall review of the microbial safety of fruits and vegetables, preservative method including major preservative factors used in pickling technology, concept and mechanism of hurdle technology. Fruits and vegetables can become contaminated with pathogenic microorganisms from different sources. Pickling or fermentation is one traditional method used to preserve fruits and vegetables. Acidified pickled food products may not be safe against some pathogens which have high resistance to acidic pH. E. coli O157:H7 could be a pathogen of greatest concern in pickled products because of its low infectious dose and high acid tolerance. In pickled products, acid, salt, and heating are major factors that contribute to food preservation and these factors are applied in combination. Current regulations and industrial practices regarding acidified pickled foods are possibly out of date because of the scarcity of information on pathogen control in these foods. Therefore, finding the combined effects of three major factors is necessary to formulating the correct application of preservation factors that can increase the microbial safety and total quality of pickled products.

Safety:

1. Use commercial vinegar with a minimum acidity of 5%.2. Hard water reduces the acidity of pickling solutions and can affect the growth of bacteria. So only use soft drinking quality water or distilled water.
2. Wash produce carefully to remove dirt and bacteria.
3. Internal pasteurizing temperature should be 74°C for 15 min followed by prompt cooling.
4. Destruction of *Escherichia coli* O157:H7.

Safety:

1. Inactivation of Total aerobic bacteria and lactic acid bacteria.

Hurdle Technology: Limitation

- High cost
- High level of humectants and preservatives are required

- Storage can be done maximum up to 3-6 months
- Restricted to meat sector
- High amount of antimicrobials additives (i.e. chemical over loading)

recently, by understanding Hurdle technology. More fundamental and practical research is required to continue down this fruitful path.

The application of hurdle technology should enhance the overall quality of food.

Sl.No.	Food	Hurdles	Advantages
1.	Pickled fruits and vegetables (Lee, 2004)	a) Acetic acid b) Salt c) Heating	✓ Acetic acid = Lowers Ph ✓ Salt = Lowers aw ✓ Heating increases the microbial stability ✓ Inactivation of Escherichia coli O157:H7
2.	Mango slice (Ulloa *et al* 2009)	a) Sucrose - 250 g b) Sodium chloride - 1.5 g c) Potassium sorbate - 0.5 g d) Sodium bisulphate - 0.25 g per kilogram of solution	✓ Improved self-life with better antioxidant power
3.	Kimchi (Kim *et al* 2012)	a) Garlic chive (140 mg/100 g of kimchi) b) Mustard c) Control of kimchi fermentation using fruits or fruit seed extracts. d) Essential oil of persimmon leaves: e) Green tea leaf (*Camellia sinensis* L.) extract and green tea	✓ Shelf life of kimchi could be extended by 1.5 days by adding garlic chive extract at the early stage of fermentation. ✓ kimchi containing >0.3% mustard extract showed significantly higher scores for most of the sensory attributes. ✓ inhibition of growth of LAB in kimchi through the addition of fruit and fruit seed extracts ✓ The fermentation period of kimchi can be extended by 5to 7 days by adding essential oil of persimmon leaves. ✓ Use of green tea catechins as natural preservatives for kimchi **Source: Neeha (2014)**

Future Perspectives of Hurdle Technology

Food stability and quality are determined by empirical research, and more Predictive microbiology and HACCP should be used in the validation of the proposed user guide for food design.

CONCLUSION

Scholars have investigated many obstacles and continue to conduct experiments to identify novel obstacles and their combinations for the efficient deactivation of microorganisms, ensuring an improved and secure food product. When combined with conventional barriers, even the most cutting-edge techniques for food preservation-like pulsed technologies-work better. Several hurdles such as marination, cooking and glycerol have been applied in the production of shelf stable chicken lollipop (Singh *et al* 2014). There is an increasing demand for fresh and minimally processed food items due to the expanding economy. Traditional fruit preservation techniques alter the fruit's sensory and nutritional qualities based on a single preservation parameter. The hurdle technique is effective preservation of food goods since it modifies the product's sensory and nutritional qualities to a minimal, making it more valuable and palatable than when produced through traditional means. For this reason, hurdle technology is likely to continue to be the backbone of food preservation in the future.

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