



Packaging design: materials and innovations used in food packaging

Versha Devi

Abstract

Food packaging has progressed from being just a package for food to one that will now actively influence food safety. Many packets are only just cans, but they have properties designed to secure the food. This involves oxygen, moisture, and taste barriers. The aim of this paper is to address the importance of understanding customer expectations in order to properly design product packaging and achieve the desired role in the minds of customers. Consumers have shown common interpretations of product packaging techniques, showing that a common understanding of what a specific packaging entails remains. As a result, public opinion should guide packaging designers in meeting customers' needs. Food packaging helps protect foods against physical, chemical and environmental factors that could possibly contaminate all of the food if not packaged correctly.

Keywords: bundling, product positioning, consumer behaviour, product.

Introduction:

Packaging of new foods grown from the ground is one of the more significant strides in the long and entangled venture from producer to customer. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10.)

Packaging is significant in light of the fact that it helps nourishment dissemination, and quick and solid dispersion makes a difference evacuate nearby nourishment surpluses, permits shoppers increasingly decision in the food sources accessible and serves to lessen ailing health. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10). Bundling likewise diminishes post reaping misfortunes, which together with giving access to bigger markets, enables makers to expand their livelihoods. (Ahvenainen R, editor. Novel

food packaging techniques. Elsevier; 2003 Jun 10). Along these lines, sufficient bundling in creating nations affects both the example of nourishment utilization and the sum of nourishment customer. (Ahvenainen, R. ed., 2003. *Novel food packaging techniques*. Elsevier.)

The agro climatic states of our nation are perfect for agribusiness and agriculture. Our nation's economy is additionally overwhelmingly agrarian. Farming bolsters 64% of workforce and procures 19% of our fares. (Ngure JW, Aguyoh JN, Gaoquiong L. Interactive effects of packaging and storage temperatures on the shelf-life of okra. *ARPN J. Agric. Bio. Sci.* 2009;4(3):43-52.) Polymeric Films Used for Packaging of Fruits and Vegetables India is the biggest maker of natural products on the planet (46 million tons) with a worldwide portion of over 10% and the second biggest maker of vegetables (80 million tons) with a worldwide portion of over 15%. (Ngure JW, Aguyoh JN, Gaoquiong L. Interactive effects of packaging and storage temperatures on the shelf-life of okra. *ARPN J. Agric. Bio. Sci.* 2009;4(3):43-52.) India is the biggest maker of banana (15% of the world generation) and mango (59% of the world creation) and India is second biggest maker of onion with a worldwide portion of 12.6% and third biggest maker of cauliflower with a worldwide portion of 6.3%. (Ahvenainen, R. ed., 2003. *Novel food packaging techniques*. Elsevier).

The specialized reason for bundling are:

- To contain nourishments (to hold the substance and keep them perfect and secure without spillage or breakage until they are utilized). [Paine FA, Paine HY. *A handbook of food packaging*. Springer Science & Business Media; 2012 Dec 6.]
- To ensure nourishments against a scope of dangers during dissemination and capacity (to give a hindrance to earth, small scale life forms and different contaminants, and assurance against harm brought about by creepy crawlies, flying creatures and rodents, warmth, oxidation, and dampness pickup or misfortune). [Paine FA, Paine HY. *A handbook of food packaging*. Springer Science & Business Media; 2012 Dec 6.]
- To give helpful taking care of all through the creation, stockpiling and appropriation framework, including simple opening, administering and re-fixing, and being appropriate for simple transfer, reusing or re-use. (Paine FA, Paine HY. *A handbook of food packaging*. Springer Science & Business Media; 2012 Dec 6.)

• To empower the shopper to recognize the nourishment, and give directions with the goal that the nourishment is put away and utilized accurately. (Paine FA, Paine HY. A handbook of food packaging. Springer Science & Business Media; 2012 Dec 6.)

2.Packaging Requirements:

Distinctive plant items need various sorts of bundles relying upon their physical, anatomical and physiology (predominantly transpiration, breath and ethylene creation rate) nature furthermore, defences less ness to microbial rot. Temperature, relative dampness and ventilation likewise plays an important job in deciding the post-collect existence of the crisp produce. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992). Along these lines, the bundling prerequisites for new produce can be abridged as (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992.):

- Protection against wounding and physical damage. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992).
- Protection against microbial defilement and weakening. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992).
- Provide ventilation for breath and trade of gases. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992).
- Protect against dampness/weight reduction. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992).
- Slow down breath rate, defer aging and increment stockpiling life. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992).
- Control ethylene fixations in the bundle. (Paine FA, Paine HY. A Handbook of Food Packaging. Springer Science & Business Media; 1992).

3.Packaging Materials: - The bundles for crisp products of the soil can be delegated:

3.1• Consumer/Retail packs.

3.2. Transport/Bulk packs

Buyer Packs: -Customer bundles are little in size and intended to hold ½ dozen – 1 dozen organic products or ½ kg to 2 kg of vegetables. [Deliya MM, Parmar MB. Role of Packaging on Consumer Buying Behaviour â€ “Paton District. global Journal of management and Business research. 2012 Jun 18;12(10)] Numerous sorts of bundles regarding structures and materials are utilized as buyer packs. (Deliya MM, Parmar MB. Role of Packaging on Consumer Buying Behaviour â€ “Paton District. global Journal of management and Business research. 2012 Jun 18;12(10).

The determination foundation for the kind of purchaser pack relies upon showcasing qualities of the item. The most normally utilized bundles are recorded underneath [Deliya MM, Parmar MB. Role of Packaging on Consumer Buying Behaviour â€ “Paton District. global Journal of management and Business research. 2012 Jun 18;12(10).]:

- **Flexible Plastic Films:** Different kinds of adaptable plastic movies like LDPE (Polyethylene), PVC (Poly Vinyl Chloride), PP (Polypropylene) and cellulose acetic acid derivation movies are utilized for bundling of green produce. (Roach KV, Cetiner MS, Faherty VE, Ventura FP, inventors; TW Kutter Inc, assignee. Forming and filling flexible plastic packaging. United States patent US 4,918,907. 1990 Apr 24.) These movies are for the most part utilized as pockets with gaps punched at standard interims to permit breath. They are accessible in a wide scope of thicknesses and grades and can be designed to control the natural gases inside the pocket. LDPE is the most broadly utilized material. (Roach KV, Cetiner MS, Faherty VE, Ventura FP, inventors; TW Kutter Inc, assignee. Forming and filling flexible plastic packaging. United States patent US 4,918,907. 1990 Apr 24).

- **Trays with Overwrap:** The plate utilized are typically made of shaped mash plate or plastic material like EPS, PVC and PP. (Reskow DW, inventor; Tekni-Plex Inc, assignee. Moulded plastic overwrap tray. United States patent US 5,503,858. 1996 Apr 2.) The produce is put in singular holes with the goal that scraped area and wounding is dodged during transportation. (Reskow DW, inventor; Tekni-Plex Inc, assignee. Moulded plastic overwrap tray. United States patent US 5,503,858. 1996 Apr 2.) The plate likewise gives padding impact

to the produce. (Reskow DW, inventor; Tekni-Plex Inc, assignee. Moulded plastic overwrap tray. United States patent US 5,503,858. 1996 Apr 2.)

- **Plastic Punnets:** These are solid, adaptable, clear, splendid holders, which offer item perceivability furthermore, are given openings for ventilation, which keeps the produce new. (Ahvenainen, R. ed., 2003. *Novel food packaging techniques*. Elsevier). These compartments are nourishment grade, unscented, light weight, stackable and recyclable and give great introduction and are either made of PET, PVC or PP. [Aharoni N, Rodov V, Fallik E, Porat R, Pesis E, Lurie S. Controlling humidity improves efficacy of modified atmosphere packaging of fruits and vegetables. In Europe-Asia Symposium on Quality Management in Postharvest Systems-Eurasia 2007 804 2007 Dec 3 (pp. 121-128).]

- **Plastic Net sacks (Extruded & Woven):** The plastic net packs have the component to extend and oblige all sizes and states of produce. (Wolske EH, inventor; Bemis Co Inc, assignee. Packeting net bags. United States patent US 4,207,983. 1980 Jun 17). These packs are accessible in move structure or in pre-cut lengths with stretch width of 200 mm – 400 mm. (Wolske EH, inventor; Bemis Co Inc, assignee. Packeting net bags. United States patent US 4,207,983. 1980 Jun 17). By enabling air to course in and around the produce, these net packs draw out the freshness and time span of usability of the new produce. (Wolske EH, inventor; Bemis Co Inc, assignee. Packaging net bags. United States patent US 4,207,983. 1980 Jun 17.) They too dispense with pack build up accordingly averting deterioration and wastage. They make a bright point of offer presentation by permitting clear perceivability of the substance, upgrading the characteristic shades of new produce and these are commonly made of HDPE (High Density Polyethylene) or PA (Polyamide). [Wolske EH, inventor; Bemis Co Inc, assignee. Packeting net bags. United States patent US 4,207,983. 1980 Jun 17.]

- **Foam Sleeve:** This is a plastic cylindrical film made of polyethylene froth accessible in various hues, breadths and lengths. (Zunkel GD, inventor; Halliburton Co, assignee. Foam gravel packer. United States patent US 4,628,993. 1986 Dec 16). It very well may be effectively slipped over the individual organic products in a cozy fit structure. It gives a padding impact and ensures the crisp produce against scraped spot and scratches during travel. (Zunkel GD, inventor; Halliburton Co, assignee. Foam gravel packer. United States patent US 4,628,993. 1986 Dec 16).

- **Light Weight Plastic Crates:** These are lightweight boxes, which need not be placed into an external pack for transportation. (Darrah IJ, Williams DW, inventors; Monsanto Co, assignee. Lightweight plastic container

case-packing method and apparatus. United States patent US 3,869,843 1975 Mar 11). The apertures give ventilation and keep the produce new and the containers are stackable and have high pressure quality and thusly give sufficient security to the crisp produce stuffed inside. (Darrah IJ, Williams DW, inventors; Monsanto Co, assignee. Lightweight plastic container case-packing method and apparatus. United States patent US 3,869,843. 1975 Mar 11). These cases are sterile, spotless, reusable and can be reused. They can be made of HDPE or PP. (Darrah IJ, Williams DW, inventors; Monsanto Co, assignee. Lightweight plastic container case-packing method and apparatus. United States patent US 3,869,843. 1975 Mar 11).

• **Shrink Wrap:** One of the most up to date slants in new produce bundling is the psychologist wrapping of individual produce. [Geeson JD. Modified atmosphere packaging of fruits and vegetables. In International Symposium on Postharvest Handling of Fruit and Vegetables 258 1988 Aug 29 (pp. 143-150)]. The best bit of leeway of individual psychologist wrapping is its capacity to control dampness misfortune. [Geeson JD. Modified atmosphere packaging of fruits and vegetables. In International Symposium on Postharvest Handling of Fruit and Vegetables 258 1988 Aug 29 (pp. 143-150)]. By diminishing the transpiration rate and keeping up the natural product solidness the film frames an obstruction which builds the protection from water fume. [Geeson JD. Modified atmosphere packaging of fruits and vegetables. In International Symposium on Postharvest Handling of Fruit and Vegetables 258 1988 Aug 29 (pp. 143-150)]. The transpiration rate can be decreased 5 to multiple times utilizing specific porous plastic films. The individual natural product is inexactly fixed in an adaptable film. [Geeson JD. Modified atmosphere packaging of fruits and vegetables. In International Symposium on Postharvest Handling of Fruit and Vegetables 258 1988 Aug 29 (pp. 143-150)]. The film is then contracted firmly around the produce by going these packs through a warmth contracted burrow where they are presented to hot blown air for a very brief period (few moments) and the crisp produce is then cooled by fast ventilation. [Geeson JD. Modified atmosphere packaging of fruits and vegetables. In International Symposium on Postharvest Handling of Fruit and Vegetables 258 1988 Aug 29 (pp. 143-150)]. The film most usually utilized are LDPE or LLDPE. [Geeson JD. Modified atmosphere packaging of fruits and vegetables. In International Symposium on Postharvest Handling of Fruit and Vegetables 258 1988 Aug 29 (pp. 143-150).]

• **Corrugated Boxes/Cartons:** Many organic products like mangoes, apples, grapes, and so forth are pressed in little packs of 2-4 kgs, either in layered boxes made of paper board or polymers like polypropylene. (Wei

CC, inventor; CALABASH CO Ltd, assignee. Fruit and vegetable carton. United States patent US 3,392,904. 1968 Jul 16). These containers/containers are light-weight with great pressure quality. They can be printed to have a great rack advance. (Wei CC, inventor; CALABASH CO Ltd, assignee. Fruit and vegetable carton. United States patent US 3,392,904. 1968 Jul 16).

Transport Packs: - Transport bundles are intended for long separation transportation in limits going from 4 – 5kgs to 20 – 25 kgs. (Sirivatanapa S. Packaging and transportation of fruits and vegetables for better marketing. Postharvest management of fruit and vegetables in the Asia-Pacific region. 2006:43-8). These packs must withstand effects, pressure and vibration during transport. The vehicle bundles can be extensively arranged as unbending holders made of wood, ridged fibre board or plastics and adaptable compartments, for example, sacks made of plastic. (Sirivatanapa S. Packaging and transportation of fruits and vegetables for better marketing. Postharvest management of fruit and vegetables in the Asia-Pacific region. 2006:43-8). Alongside these materials some conventional materials utilized are (jute sacks), wooden boxes and bamboo bushels. (Sirivatanapa S. Packaging and transportation of fruits and vegetables for better marketing. Postharvest management of fruit and vegetables in the Asia-Pacific region. 2006:43-8). The assortment of bundling materials utilized for transport bundling of green produce are recorded (lal Basediya A, Samuel DV, Beera V. Evaporative cooling system for storage of fruits and vegetables-a review. Journal of food science and technology. 2013 Jun 1;50(3):429-42):

- **Bamboo Baskets:** Bamboo bins are broadly utilized even today as transport packs in local advertise. (lal Basediya A, Samuel DV, Beera V. Evaporative cooling system for storage of fruits and vegetables-a review. Journal of food science and technology. 2013 Jun 1;50(3):429-42). They are accessible in different shapes, sizes and plans however they don't have unbending nature and stack ability during long separation transport. (lal Basediya A, Samuel DV, Beera V. Evaporative cooling system for storage of fruits and vegetables-a review. Journal of food science and technology. 2013 Jun 1;50(3):429-42). Today plastic bushels or Kilta's have additionally been created what's more, utilized for capacity & transportation of natural products & vegetables. (lal Basediya A, Samuel DV, Beera V. Evaporative cooling system for storage of fruits and vegetables-a review. Journal of food science and technology. 2013 Jun 1;50(3):429-42).

- **Wooden Boxes:** The traditional crates have been supplanted by wooden boxes as they give better security to the crisp produce against transportation perils. (Hardenburg RE, Watada AE, Wang CY. The commercial

storage of fruits, vegetables, and florist and nursery stocks. US Department of Agriculture; 1986). They have high cut obstruction, great elasticity just as pressure quality; yet they consume more space and add on to the tare weight. (Hardenburg RE, Watada AE, Wang CY. The commercial storage of fruits, vegetables, and florist and nursery stocks. US Department of Agriculture; 1986). Additionally, the nails cause wounds to the produce during long transportation. (Hardenburg RE, Watada AE, Wang CY. The commercial storage of fruits, vegetables, and florist and nursery stocks. US Department of Agriculture; 1986).

Be that as it may, the utilization of wooden boxes is disheartened now-a-days as it legitimately advances deforestation. (Hardenburg RE, Watada AE, Wang CY. The commercial storage of fruits, vegetables, and florist and nursery stocks. US Department of Agriculture; 1986.)

- **Corrugated Fibre Board/Plastic Boxes:** Corrugated fibreboard boxes are generally utilized as transport/shipping holders for new produce as a result of the accompanying favourable circumstances: (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Low cost to quality and weight proportion. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Good padding properties. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Smooth and non-rough surface. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Good printability on the external surface of the board. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Easy to set up and collapsible for capacity. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Reusability and recyclable. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).
- Can be made in high volumes. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).

- Can be given ventilation by punching gaps. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).

Since the CFB boxes have poor wet quality, presently a-days they are covered with plastic film like LDPE, PP or PVC. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10). Plastic folded boxes made of PP and HDPE are mostly supplanting CFB boxes as a result of their low weight to quality proportion, high level of water opposition and re-ease of use. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10). Be that as it may, its padding properties are not similar to CFB. (Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10).

- **Plastic Crates:** These are normally made of HDPE or PP by infusion shaping. Polyethylene has higher sway quality and a low corruption by ultra-violet Wooden Boxes Corrugated Fibre Board Box 238 radiation while polypropylene has a superior scratch opposition. The presentation of both materials can be improved by including cancer prevention agents and UV protectants (for daylight security). [Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10.]

The benefits of plastic boxes are:

- As these containers are solid and inflexible they can be utilized for some, ventures, making the expense per venture moderately low. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10).
- Different sizes and shapes are accessible. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10).
- They can be effectively cleaned and purified. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10).
- They are solid and climate safe and in view of this they can be utilized in moist zones. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10).

These containers are both of stackable, stack-home or collapsible in structure. Collapsible plastic boxes are the costliest cases pursued by stack-home and afterward the stacking containers. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10).

The collapsible cases diminish the extra room necessity and transport cost of void compartments. The ordinary limit changes between 20 – 40 kgs. (Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10).

• **Sacks:** These are commonly used to bring the crude materials from the field. Plastics Woven Sack Jute Sacks Light Weight Plastic Crate. (Ferre JF, inventor; Intermas SA, assignee. Extruded plastics net bag. United States patent US 5,385,766. 1995 Jan 31). The normally utilized materials are cotton, jute, plastic (HDPE, PP) and they are helpful in light of minimal effort, high quality, re-usability requires less space for purges. (Ferre JF, inventor; Intermas SA, assignee. Extruded plastics net bag. United States patent US 5,385,766. 1995 Jan 31). In any case, they have low insurance against cut, pressure, vibration and effect wounds. (Ferre JF, inventor; Intermas SA, assignee. Extruded plastics net bag. United States patent US 5,385,766. 1995 Jan 31). They are poor in stack ability and these sacks are typically joined with bamboo crates and wooden boxes to improve padding and diminish wound damage and misfortunes during transportation. (Ferre JF, inventor; Intermas SA, assignee. Extruded plastics net bag. United States patent US 5,385,766. 1995 Jan 31).

Conclusion: According to the current report, many people chose the package design process, and the provider of board content may take a more active role in this process by including consumers in the process. Product packaging also has many other important functions of product safety, such as isolation, shipping, storage, and information display (Lee and Lye, 2003). The primary function of food packaging on the shelves, like all point-of-purchase contact vehicles, is to attract interest by cutting through the strategic congestion in the shop or at the supermarket.

REFERENCES:

1. Ahvenainen R, editor. Novel food packaging techniques. Elsevier; 2003 Jun 10
2. Ngure JW, Aguyoh JN, Gaoquiong L. Interactive effects of packaging and storage temperatures on the shelf-life of okra. *ARPN J. Agric. Bio. Sci.* 2009;4(3):43-52.
3. Franklin, B. (1994). *Packaging politics* (Vol. 187). London: Edward Arnold.
4. Lee, S. G., & Lye, S. W. (2003). Design for manual packaging. *International Journal of Physical Distribution & Logistics Management*.
5. Robertson, G. L. (2016). *Food packaging: principles and practice*. CRC press.
6. Tummala, R. R., Rymaszewski, E. J., & Lee, Y. C. (1989). *Microelectronics packaging handbook*.
7. Ampuero, O., & Vila, N. (2006). Consumer perceptions of product packaging. *Journal of consumer marketing*.
8. Han, J. H. (2003). Antimicrobial food packaging. *Novel food packaging techniques*, 8, 50-70.
9. Yam, K. L. (Ed.). (2010). *The Wiley encyclopedia of packaging technology*. John Wiley & Sons.
10. Paine FA, Paine HY. A handbook of food packaging. Springer Science & Business Media; 2012 Dec 6.
11. Deliya MM, Parmar MB. Role of Packaging on Consumer Buying Behaviour â€“Paton District. *global Journal of management and Business research*. 2012 Jun 18;12(10).
12. Roach KV, Cetiner MS, Faherty VE, Ventura FP, inventors; TW Kutter Inc, assignee. Forming and filling flexible plastic packaging. United States patent US 4,918,907. 1990 Apr 24.
13. Reskow DW, inventor; Tekni-Plex Inc, assignee. Moulded plastic overwrap tray. United States patent US 5,503,858. 1996 Apr 2.
14. Aharoni N, Rodov V, Fallik E, Porat R, Pesis E, Lurie S. Controlling humidity improves efficacy of modified atmosphere packaging of fruits and vegetables. In *Europe-Asia Symposium on Quality Management in Postharvest Systems-Eurasia 2007* 804 2007 Dec 3 (pp. 121-128).
15. Aharoni N, Rodov V, Fallik E, Porat R, Pesis E, Lurie S. Controlling humidity improves efficacy of modified atmosphere packaging of fruits and vegetables. In *Europe-Asia Symposium on Quality Management in Postharvest Systems-Eurasia 2007* 804 2007 Dec 3 (pp. 121-128).
16. Zunkel GD, inventor; Halliburton Co, assignee. Foam gravel packer. United States patent US 4,628,993. 1986 Dec 16.
17. Darrah IJ, Williams DW, inventors; Monsanto Co, assignee. Lightweight plastic container case-packing method and apparatus. United States patent US 3,869,843 1975 Mar 11.
18. Geeson JD. Modified atmosphere packaging of fruits and vegetables. In *International Symposium on Postharvest Handling of Fruit and Vegetables 258* 1988 Aug 29 (pp. 143-150).
19. Wei CC, inventor; CALABASH CO Ltd, assignee. Fruit and vegetable carton. United States patent US 3,392,904. 1968 Jul 16.
20. Sirivatanapa S. Packaging and transportation of fruits and vegetables for better marketing. *Postharvest management of fruit and vegetables in the Asia-Pacific region*. 2006:43-8.
21. lal Basediya A, Samuel DV, Beera V. Evaporative cooling system for storage of fruits and vegetables-a review. *Journal of food science and technology*. 2013 Jun 1;50(3):429-42.
22. Hardenburg RE, Watada AE, Wang CY. The commercial storage of fruits, vegetables, and florist and nursery stocks. US Department of Agriculture; 1986.
23. Realini, C. E., & Marcos, B. (2014). Active and intelligent packaging systems for a modern society. *Meat science*, 98(3), 404-419.
24. Svanes, E., Vold, M., Møller, H., Pettersen, M. K., Larsen, H., & Hanssen, O. J. (2010). Sustainable packaging design: a holistic methodology for packaging design. *Packaging Technology and Science: An International Journal*, 23(3), 161-175.
25. Vermeiren, L., Devlieghere, F., van Beest, M., de Kruijf, N., & Debevere, J. (1999). Developments in the active packaging of foods. *Trends in food science & technology*, 10(3), 77-86.
26. Eilert, S. J. (2005). New packaging technologies for the 21st century. *Meat science*, 71(1), 122-127.
27. Suppakul, P., Miltz, J., Sonneveld, K., & Bigger, S. W. (2003). Active packaging technologies with an emphasis on antimicrobial packaging and its applications. *Journal of food science*, 68(2), 408-420.
28. Jasinover R, inventor. Container. United States patent US 3,598,233. 1971 Aug 10.
29. Ferre JF, inventor; Interma SA, assignee. Extruded plastics net bag. United States patent US 5,385,766. 1995 Jan 31.

30. Garillot, F., Gonthier, G., Mahboubi, A., & Rideau, L. (2009, August). Packaging mathematical structures. In *International Conference on Theorem Proving in Higher Order Logics* (pp. 327-342). Springer, Berlin, Heidelberg.

