KNOWLEDGE – International Journal
Vol. 23.3
Budva, Montenegro, May, 2018

POPULATION PERCEPTION OF ACTIVE AND INTELLIGENT FOOD PACKAGING

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Abstract: Due to the demands on product safety and shelf life extension, food packaging has developed. New packaging techniques are result of the increased demands and the consumer preferences toward food products. The aim of this paper was to determine the knowledge and acceptance towards active and intelligent packaging. The data is collected from own research obtained from the field by using method of examination. The survey was conducted on a sample of 105 respondents. The analysis of the survey results showed that the knowledge of active and intelligent packaging among the population in the Republic Macedonia is inadequate.
Keywords: novel packaging, active packaging, intelligent packaging, consumer

INTRODUCTION

Food packaging is a technological process in which products are places in suitable packaging. This process enables easier and more reliable manipulation of products, during their storage and transportation. For food packaging, different types of packaging material are used. (Jankulovski, 2015)
Due to the requirements on product safety and shelf life extension, food packaging has been developed. New packaging techniques are the result of the increased demands and the consumer preferences toward food products.
Rapid growth of novel packaging in food segment is contributed by the enormous use of packages foods, rising need of prepared food like use of microwave meals and growing use of smaller size food packages. (Restuccia et al. 2010)
The 'active packaging' has a role to extend the shelf-life of the food or even improve its quality. While the role of 'intelligent packaging' is to monitor the freshness of the food.

DEFINING ACTIVE AND INTELLIGENT PACKAGING

There are many definitions for active and smart packaging such as:
Active when it performs some desired role in food preservation other than providing an inert barrier to external conditions (Hutton, 2003).
Active when the packaging elements change the condition of the packed food to extend shelf life or improve safety or sensory properties, while maintaining quality of packaged food (Ahvenainen, 2003)
Packaging system, which monitor the condition of packaged foods to give information about the quality of the packaged food during transport and storage. (Ahvenainen, 2003)
Two definitions are included in the Regulation included in the Law for Food Safety:
"Active materials and products" are materials and products intended for prolonging the shelf life or improving the condition of the packaged food; they contain components that release or absorb substances in/from the packaged food or the environment.
"Intelligent materials and products" are materials and products that follow the condition of the packaged food or the environment surrounding the food.

ACTIVE PACKAGING

Active packaging techniques for preservation and improving quality and safety of foods can be divided into three categories: absorbers (i.e. scavengers), releasing systems and other systems. Absorbing (scavenging) systems remove undesired compounds compounds such as oxygen, carbon dioxide, ethylene, taints and other specific compounds. (Ahvenainen, 2003)
Active packaging can be classified into two main types: non-migratory active packaging acting without intentional migration, and active releasing packaging allowing a controlled migration of non-volatile agents or an emission of volatile compounds in the atmosphere surrounding the food. (Dario et al. 2008)

Table 1. Example of sachet, label and film type scavenging active packaging systems. (According to Ahvenainen, 2003)

Packaging type	Example of working principle/mechanism/reagents	Purpose	Examples of possible applications
Oxygen absorbers (sachets, labels, Films, corks)	Ferro-compounds, Ascorbic acid, metal Salts, glucose Oxidases, alcohol oxidase	Reduction/preventing of mould, yeast and aerobic bacteria growth Prevention of oxidation of falts, oils, vitamins colours Prevention of demage by worms, insects and insect eggs	Cheese, meat products, ready-to-eat products, bakery products, coffe, tea, nuts, milk powder
Carbon dioxide absorbers (sachets)	Calcium hydroxide and sodium hydroxide or potassium hydroxide Calcium oxide and silica gel	Removing of carbon dioxide formed during storage in order to prevent bursting of a package	Roasted coffee Beef jarkey Dehydratet poultry products
Ethylene absorbers (sachets, films)	Aluminium oxide and potassium permanganate (sachets) Activated carbon + metal catalyst (sachets) Zeolite (films) Clay (films)	Prevention of too fast ripening and sofening	Fruits like apples, apricots, bananna, mango, cucumber, tomatoes, avocados and vegetetables

Releasing systems actively add or emit compounds to the packaged food or into the headspace of the packaging.

Table 2. Examples of sachet and film type releasing active packaging system. (According to Ahvenainen, 2003)

Packaging type	Examples of working principle/mechanism/reagents	Purpose	Examples of possible applications
Carbon dioxide emitters (sachets)	Ascorbic acid Sodium hydrogen Carbonate and ascorbate	Growth inhibition of gram-negative bacteria and moulds	Vegetables and fruits, fish, meat, poultry
Ethanol emitters (sachets)	Ethanol/water mixture adsorbed onto silicon dioxide powder generating ethanol vapour	Growth inhibition of moulds and yeast	Bakery products (preferably heated before consumption) Dry fish
Sulphur dioxide emitters (sachets)	Sodium metabisulfite incorporated in microporous material	Inhibition of mould growth	Fruits

Even food contact antimicrobial systems with an assumed non-intended migration (e.g. silver or silver based systems, other immobilised or grafted biocides, are known to exhibit some degree of migration. (Dario et al. 2008)

In active packaging, nanotechnology has a great interesting potential because nanostructures display a high surface-tovolume ratio and specific surface properties. Nanotechnologies such as nano(bio)composites and electro spun nano-fibre based structures are able to enhance desired properties or to introduce new additional effective functionalities with small amount of nanofillers. (Lagaron et al. 2005)

INTELLIGENT PACKAGING

Intelligent packaging include indicators such as external indicator and internal indicators.

Intelligent tags such as electronic labelling, designed with ink technology in a printed circuit and built-in battery radio-frequency identity tags, all places outside the primary packaging, are being developed in order to increase the efficiency of the flow of information and to offer innovative communicative functions. Diagnostic indicators were first designed to provide information on the food storage conditions, such as temperature, time, oxygen or carbon dioxide content, and thus, indirectly, information on food quality, as an interesting complement to end-use dates. (Dario et al. 2008)

Based on polymerisation rate, diffusion, chemical or enzymatic reactions, the most commonly used of these visual indicators are critical temperature indicators, time/temperature indicators and leak indicators. This first generation of indicators can be considered as ‘‘indirect indicators’’ of food freshness. The trend in this field is to develop direct indicators of food quality because of their ability to provide more precise and targeted information on quality attributes (Gontard, 2004).

Table 3. Examples for external and internal indicators. (According to Ahvenainen, 2003)

Indicator	Principle/reagents	Gives information about	Application
Time-temperature indicators (external	Mechanical Chemical Enzymatic	Storage conditions	Foods stored under chilled and frozen conditions
Oxygen indicator (internal)	Redox dyes pH dyes Enzymes	Package leak	Foods stored in packages with reduced oxygen concentration
Carbon dioxide indicator (internal)	Chemical	Storage conditions Package leak	Modified or controlled Atmosphere food packaging

MATERIAL AND METHODS

The aim of this paper was to determine the knowledge and acceptance towards active and intelligent packaging.

The methodological approach in this paper is based on the descriptive method on the basis of the data that has been collected from the field.

The data is collected from own research obtained from the field by using method of examination. The survey was conducted on a sample of 105 respondents.

The data is collected from own research obtained from the field by using the method of examination. The examination is done by using empirical techniques of survey and personal interviews with a pre-structured questionnaire to group participants from different regions in the Republic of Macedonia.

RESULTS AND DISCUSSION

Analyses for this paper were made on a total 105 participants, from different regions in the Republic of Macedonia. From 105 participants 55 were woman and 50 man. All of them were being above the age of 20. When they were asked what should be the real purpose of food packaging, 40% responded a) protecting the food against spoilage, 20% answered b) easy to use and 40% responded with c) inform the consumer about the content of food. When they were asked if they have heard of any innovative packaging 61,90% answered with a) yes and 38,10% answered with b) no. When they were asked what is their expectation from an innovative packaging, with possible answers a) increasing food products shelf life, b) making it possible to visually observe the quality, freshness and history of foods. 78,10% of the participants answered a) increasing food products shelf life, and 21,90% answered b) making it possible to visually observe the quality, freshness and history of foods. When the participants were asked, do they think that the innovative packaging will contribute to increase food products shelf life, protect the food against spoilage and making it possible to observe the history, quality and freshness of food, 41,90 participants answered a) yes, 50,48% answered b) no, and 7,62% answered c) I don’t know. The conducted survey showed that the term “active packaging” is known to 14,20% of respondents, while only 16% knew what is “intelligent packaging”.

Table 4. Knowledge of examples for active and intelligent packaging and their purpose

Packaging type	Purpose	Declarations of respondents (%)		
		Yes	No	I don't know
Absorbing (scavenging) systems remove undesired compounds compounds such as oxygen, carbon dioxide, ethylene, taints and other specific compounds.	Reduction/preventing of mould, yeast and aerobic bacteria growth Prevention of oxidation of falts, oils, vitamins colours Prevention of demage by worms, insects and insect eggs Prevention of too fast ripening and sofening	26,67%	30,48%	42,85%
Releasing systems actively add/emit compounds to the packaged food or into the headspace of the packaging.	Inhibition of mould growth and gram-negative bacteria	25,71%	34,29%	40%
Use of time-temperature indicators (external	Gives information about storage condition	7,62%	39,05%	53,33%
Use of carbon dioxide and oxygen indicator (internal)	Gives information about storage condition and package leak	20,95%	28,57%	50,48%

Absorbing systems were most known for the respondents (with 26,67% recognizing the type and the purpose of the packaging), while the use of time-temperature indicators was least known for the respondents (with 53,33% "I don't know" answers). From the results is concluded that the knowledge of active and intelligent packaging among the population in the Republic Macedonia is inadequate. Today there are many new solutions on the market, which are poorly recognized by the consumers.

CONCLUSION

Due to the requirements on product safety and shelf life extension, food packaging has been developed. New packaging techniques are the result of the increased demands and the consumer preferences toward food products. Rapid growth of novel packaging in food segment is contributed by the enormous use of packages foods, rising need of prepared food like use of microwave meals and growing use of smaller size food packages. (Restuccia et al. 2010) Various research works conducted on the active and intelligent packaging are an evidence of a major meaning of this type of packaging, mainly for food products. The conducted survey showed that the term "active packaging" is known to 14,20% of respondents, while only 16% knew what is "intelligent packaging". Absorbing systems were most known for the respondents (with 26,67% recognizing the type and the purpose of the packaging) while the use of time-temperature indicators was least known for the respondents

(with 53,33% "I don't know" answers). The analysis of the survey results showed that the knowledge of active and intelligent packaging among the population in the Republic Macedonia is inadequate. Today there are many new solutions on the market, which are poorly recognized by the consumers.

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