INTERACTION OF SUGAR CONFECTIONERY SHERBET QUALITY PARAMETERS DURING STORAGE TIME IN DIFFERENT PACKAGING

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Abstract

Essential importance for milk pomade confectionery quality assurance during storage time is alternate design of appropriate packaging technologies and materials, wherewith in this research in order to substantiate scientifically the optional shelf life of sherbet, different packaging materials in air ambiance, modified atmosphere (MAP), and active packaging with oxygen absorbers were used to approve their conformity for providing the main physical parameters and microbiological security during long term storage of investigated sugar confectionery. Shelf life can be extended significantly in conventional polymer packaging with high barrier properties: to 10–12 weeks in air ambience OPP and Multibarrier 60 HFP material; to 16 weeks in MAP 100% CO_2 and Multibarrier 60 HFP, metallised BOPET/PE and Aluthen material, exceeding neither experts' accepted hardness of 300 N nor permissible total plate count of microorganisms' level (TPC $g^{-1} \leq 10^4$).The sherbet hardness in active packaging after 16 weeks of storage in Multibarrier 60 HFP is 261.18±8.32 N, in comparison with MAP 100% CO_2 environment, it is by 11.5% lower, which is valued as positive.

Keywords: confectionery, sherbet, quality, packaging.

Introduction

Nowadays confectionery products are especially popular among children and elderly people, thus the popularity and consumption of these products are increasing (Duran et al., 2009). The European candy's market is fragmented. Leading market partners are *Mars* (14.3%), *Nestle S.A* (8.9%), and *Cadbury plc* (8.6%), the remaining part of market fill small producers – 68.3%. Leading partners in confectionery market of Latvia are Join-Stock Company *Laima*, Ltd *Skrīveru saldumi*, Ltd Pure *Chocolate,* and SIA Bona *Dea*. Join-Stock Company *Laima* is the largest producer of confectionery in Latvia, and at present *Laima* is the major sweet manufacturer in the Baltic (Laima, 2013).

With development of the choice of sugar confectionery products, most actual becomes the question about the preservation of a shelf-stable quality of the above mentioned products for a longer time, convenient use for consumers as well as opportunity to export the product more successfully (Brown, 2011).

At present in Latvia, confectionery products are sold in two ways – as bulk products which are weighed at the trading place, and as products packed at the manufacturing enterprises in a certain size of commercial packaging. Consistency of the product quality is affected significantly during shelf life by environment that surrounds the product. In oxygen environment, irreversible changes take place in foodstuffs, for instance fats and oils oxidize and become bitter, vitamin content reduces, colour changes, product loses its aromatic substances, and aerobic microorganism growth takes place. A decrease of foodstuff quality in presence of oxygen is also facilitated by increased temperature, moisture, light, especially ultraviolet light. During the course of time, more and more new opportunities are created how to preserve food quality, and scientists suggest new technologies in the packaging industry (Labuza et al., 2004; Subramaniam, 2000; Sucharzewska et al., 2003).

Important factor influencing the confectioneries shelf life is moisture migration from product and its permeation through packaging accordingly affecting the physical-chemical indices of product (Ergun et al., 2010; Willis, 1998). Ergun, Lietha and Hartel indicated that moisture content losses of candies produced on sugar bases have fundamental importance for quality maintenance. Producers should improve packaging technologies to eliminate oxygen and moisture destructive effect.

Nowadays, one of the most perspective methods how to extend the product shelf life is packaging in modified environment – vacuum or modified atmosphere packaging (MAP), where oxygen content is decreased to minimum but the carbon dioxide content is increased allowing to extend the storage time of the product by some days or even several months (Ahvenainen, 2010; Devlieghere, Debevere, 2003; Lagaron, López-Rubio, 2010). Active packaging is an innovative packaging technology, reducing the oxygen content below <0.1%, thus increasing the storage time of foodstuffs (Gibis, Rieblinger, 2011).

In order to provide the product quality constancy and extend its shelf life, it is recommended to use packaging materials with high barrier properties as well as to seek for new developments, the latest generation of biomaterials and active packaging technologies.

Scientists Londhe, Pal un Raju have investigated the shelf life of Asian sweet stuff – brown *peda* by packaging interventions, in conventional cardboard boxes, modified atmosphere and vacuum packaging techniques during storage for 40 days at 30±1 °C and concluded that brown *peda* could be best preserved in vacuum packaging without appreciable quality loss (Londhe et al., 2012). Brown *peda* is candy with low moisture and high sugar content, highly of same kind like sugar confectionery sherbet.

In this research in order to substantiate scientifically the optional shelf life of sherbet, different packaging materials in air ambiance, modified atmosphere

(MAP), and active packaging with oxygen absorbers were used to approve their conformity for providing the main physical parameters and microbiological security during long term storage of investigated sugar confectionery.

Materials and Methods

The object of the research was milk pomade sweet – sherbet with crunchy peanut chips, produced by stockholder Laima, Latvia. Dimensions of one piece of sherbet in average was 40×40×8 mm, mass 30±1 g.

Sherbet was packed by two pieces in a package, the total weight per package – 60±2 g. The size of each bag was 80×120 mm. Samples were packed in air ambience, vacuum packaging, MAP, and in active packaging with oxygen absorbers, stored at room temperature 18.0±3.0 °C, relative air moisture (RH) 40%. Samples were analyzed before packaging and after 2, 4, 6, 8, 10, 12, 14, and 16 weeks of storage.

At present research the most widely used traditional packaging technologies (in air ambience, vacuum and MAP) in conventional packaging materials (Table 1) and innovative (environmentally friendly) materials (Table 2) were studied; also oxygen absorbers in active packaging were applied, and its effect on the quality of sugar confectionery products during the storage time was estimated.

Table 1

Characteristics of conventional packaging materials used in experiments

Packaging material	Composition	Thickness, μm
OPP	Single layer, transparent OPP	40±2
Multibarrier 60 HFP	Transparent laminate, APA/TIE/PA/EVOH/PA/TIE/PE/PE	60±2
BIALON 50 HFP	Frosty white, laminate, BOPA/PE	50±3
BIALON 65 HFP	Transparent laminate, BOPA/PE	65±3
PP	Single layer, transparent PP	40±2
met.BOPET/PE	Metallised laminate BOPET/ALU/PE	65±2
Aluthen	Metallised laminate PET/ALU/PE	80±2

*Packaging in air ambience***.** At present, the most often commercially applied packaging of sugar confectionery products is air ambiance in cardboard boxes, transparent PP bags and metallised PP pouches.

Vacuum packaging. Products were put into initially from polymer film thermally sealed bag; after that, the air was removed or vacuum was created, and then the bag was sealed hermetically (Robertson, 2011).

Modified Atmosphere Packaging. For food packaging, MAP of carbon dioxide CO_2 (E 290) and nitrogen N_2 (E 941) were used, supplied by AGA, Ltd. In experiments, the following gas mixtures were used: 30% CO_2 and 70% N_2; 70% CO_2 and 30% N_2; 100% CO_2. The product was put into initially of different materials made polymer film bags; then, the air was removed from the bags and replaced by gas mixture prepared in gas mixer KM100-2MEM, and the package was hermetically sealed.

Table 2

Characteristics of biodegradable packaging materials used in experiments

Packaging material	Composition	Thickness, μm
BIO NVS	Single layer, transparent, cellophane based biodegradable NVS film	25±1
Ceramis®-PLA	PLA coated with SiOx Highbarrier properties	60±2
met. NatureFlex 23NM	Metallised / coating / cellulose film / coating	23±2
Nativia™ NTSS-30	Transparent BOPLA film	30±2
Nativia™ NZSS-20	Metallised BOPLA pouch	20±2
ECOLEAN film	Single layer, white, 40% Ca / 60% PE	78±4
BIO NVS film	Single layer, transparent, cellophane based NVS	25±1

For reduced oxygen packaging (ROP) creation (O_2 – 0%) in pouches an iron based oxygen scavenger sachets of 100 cc obtained from Mitsubishi Gas Chemical Europe Ageless® were used (Ageless, 2011). The samples were hermetically sealed by MULTIVAC C300 vacuum chamber machine and stored at the room temperature of +21.0±1 °C, (controlled by MINILog Gresinger electronic) and about 40% RH for 12 weeks under day and night conditions. The materials for experiments were selected with different water vapour transmission rate and various thicknesses. To achieve a more active oxygen removal, the active absorber was combined with MAP (100% CO_2)

The following mechanical and physical characteristics were analyzed:

1. The dynamics of gas composition in a hermetically sealed package headspace during the storage time was measured as a percentage of oxygen and carbon dioxide by a gas analyser OXYBABY® V O_2/CO_2.
2. Moisture content accordant at the storage time was determined by using verified balance KERN (Germany) with precision ±0.001g; mass loss calculation (%) – were determined by weighing on the electronic scales.
3. Hardness for freshly manufactured sherbet samples was determined as cutting force (in N) by using

TA-XTplus Texture Analyser. Cutting force was determined for six small sherbet samples from each it piece. A special probe with knife edge for a cut test HDP/BSK blade set with knife was applied. The maximum cutting force (in N) was detected at the deformation rate 10 mm s^{-1} and distance 10 mm. The samples were cut right through, in order to check whether any different structural characteristics (peanut pieces) were present under the knife inside the product or on the surface. Plotting force (in N) versus storage time (in weeks), the hardness change of sherbet stored in each gas composition in the package as well as for each packaging material was calculated. The maximum cutting force (N) was used as an index for the cut test.

4. For determination of mesophyll aerobic and facultative anaerobic microorganism colony forming unit count (TPC) a standard method was used LVS EN ISO 4833:2003. For determination of yeasts and moulds colony forming units count LVS ISO 21527-2:2008 was used.
5. Statistical analysis. Figures and Tables were developed and calculations were carried out with *MS Excel* program and *SPSS 16* statistics program. The hypotheses were checked with a *p* value method. Factors were estimated as significant when the *p* value was $<\alpha_{0.05}$. For interpretation of results it was accepted that $\alpha=0.05$ with 95% of confidence if not indicated otherwise (Arhipova, Bāliņa, 2006; Bower, 2009).

Results and Discussion

Following the assessment of analysed quality parameters of sugar confectionery product sherbet samples (in 30% CO_2 + 70% N_2, 70% CO_2 + 30% N_2, 100% CO_2), as optimal packaging environment there was accepted 100% CO_2. In order to find out the effect of the packaging materials on the sherbet, the dynamics of the product hardness during the storage time in air ambience (Fig. 1) and MAP 100% CO_2 (Fig. 2) in different packaging materials are compared. Using a five-point hedonic scale, the hardness level of samples was previously determined when still the product is good for consumption. The initial sherbet hardness have been determined 55.80±2.96 N. Sensory evaluation recognized that the product could be considered usable for consumption up its hardness 300 N. The effect of the packaging material on the hardness during the storage is significantly different ($p<0.05$). The sample kept in a cardboard box, during two weeks of storage had already reached 300 N. Sherbet packaged in biodegradable packaging materials could be stored 2 to 6 weeks; while in other packaging materials, sherbet could be stored from 6 to 16 weeks. Comparing the effect of packaging technologies on the dynamics of sherbet hardness during the storage, it has been approved that the sherbet storage time in one and the same packaging material is different (Fig. 3). If the recommended shelf life in a cardboard box was 2 weeks, then in *Multibarrier 60 HFP* it was ranging from 8 to 16 weeks. The shelf life in *Multibarrier 60 HFP* packaging and 100% CO_2 ambience could be provided to 16 weeks, in addition its hardness was below 300 N. However in the active packaging using oxygen absorbers during the same time its hardness was by 11.5% less; that could be assessed as positive result.

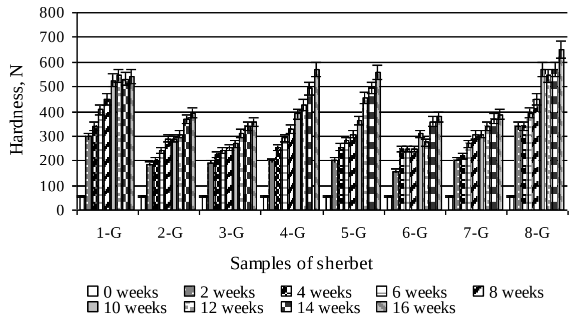

Figure 1. The dynamics of sherbet hardness during the storage time in air ambience

1-G – cardboard box; 2-G – OPP; 3-G – *Multibarrier 60 HFP*; 4-G – *BIALON 50 HFP*; 5-G – *BIALON 65 HFP*; 6-G – *ECOLEAN*; 7-G – PP; 8-G – *BIO NVS*

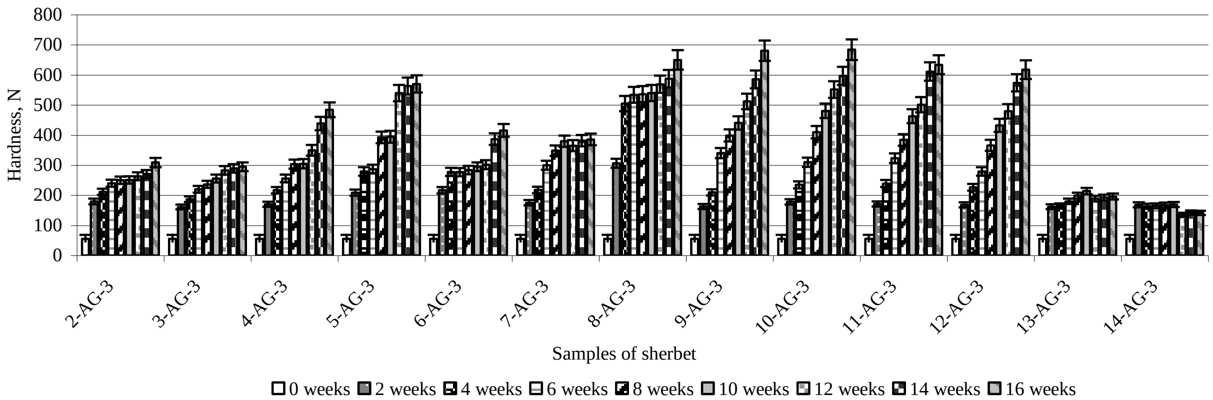

Figure 2. The dynamics of sherbet hardness in MAP (100% CO_2) during the storage time

2-AG-3 – OPP; 3-AG-3 – *Multibarrier 60 HFP*; 4-AG-3 – *BIALON 50 HFP*; 5-AG-3 –*BIALON 65 HFP*; 6-AG-3 – *ECOLEAN*; 7-AG-3 – PP; 8-AG-3 – *BIO NVS*; 9-AG-3 – *Ceramis®-PLA*; 10-AG-3 – met. *NatureFlex 23NM*; 11-AG-3 – *Nativia™ NTSS-30*; 12-AG-3 – *Nativia™ NZSS-20*; 13-AG-3 – met. BOPET/PE; 14-AG-3 – *Aluthen*

Table 3

The dynamics of sherbet sample moisture content during the storage time in air ambience, %

Samaple	Storagetime, weeks						
	0	**2**	**6**	**8**	**12**	**14**	**16**
1-G	3.40±0.12	2.27±0.10	1.67±0.09	1.63±0.09	1.50±0.09	1.53±0.09	1.31±0.08
2-G	3.40±0.12	3.05±0.12	2.74±0.11	2.56±0.11	2.55±0.11	2.29±0.10	2.26±0.10
3-G	3.40±0.12	3.17±0.12	2.95±0.11	2.81±0.11	2.55±0.11	2.40±0.10	2.20±0.10
4-G	3.40±0.12	2.61±0.11	2.46±0.10	2.31±0.10	2.14±0.10	2.14±0.10	2.03±0.10
5-G	3.40±0.12	2.82±0.11	2.56±0.11	2.36±0.10	2.19±0.10	2.00±0.10	1.80±0.09
6-G	3.40±0.12	3.14±0.12	2.95±0.11	2.92±0.11	2.50±0.10	2.28±0.11	2.20±0.10
7-G	3.40±0.12	3.27±0.12	2.68±0.11	2.53±0.11	2.30±0.10	2.19±0.10	2.08±0.10
8-G	3.40±0.12	2.51±0.11	1.99±0.09	1.66±0.09	1.48±0.08	1.18±0.08	1.10±0.08

1-G – cardboard box; 2-G – OPP; 3-G – *Multibarrier 60 HFP*; 4-G – *BIALON 50 HFP*; 5-G – *BIALON 65 HFP*; 6-G – *ECOLEAN*; 7-G – PP; 8-G – *BIO NVS*

Table 4

The dynamics of sherbet sample moisture content in MAP (100% CO_2) during the storage time, %

Samaple	Storagetime, weeks						
	0	**2**	**6**	**8**	**12**	**14**	**16**
2-AG	3.40±0.12	2.82±0.11	2.46±0.10	2.43±0.10	2.48±0.10	2.41±0.10	2.35±0.10
3-AG	3.40±0.12	2.98±0.11	3.25±0.12	2.98±0.11	2.63±0.11	2.62±0.11	2.59±0.11
4-AG	3.40±0.12	2.93±0.11	2.66±0.11	2.56±0.11	2.39±0.10	2.12±0.10	2.03±0.10
5-AG	3.40±0.12	2.82±0.11	2.44±0.10	2.35±0.10	2.02±0.10	1.77±0.09	1.71±0.09
6-AG	3.40±0.12	3.14±0.12	2.78±0.11	2.63±0.11	2.71±0.11	2.45±0.10	2.19±0.10
7-AG	3.40±0.12	3.62±0.12	2.66±0.11	2.70±0.11	2.58±0.11	2.53±0.11	2.49±0.10
8-AG	3.40±0.12	2.81±0.11	2.10±0.10	1.93±0.09	1.41±0.08	1.31±0.08	1.28±0.08
9-AG	3.40±0.12	2.87±0.11	2.55±0.11	2.19±0.10	2.03±0.10	1.59±0.09	1.19±0.08
10-AG	3.40±0.12	3.26±0.12	2.55±0.11	2.21±0.10	1.68±0.09	1.26±0.08	1.23±0.08
11-AG	3.40±0.12	2.92±0.11	2.52±0.11	2.21±0.10	1.88±0.09	1.47±0.08	1.20±0.08
12-AG	3.40±0.12	3.04±0.12	2.65±0.11	2.27±0.10	1.95±0.09	1.66±0.09	1.21±0.08
13-AG	3.40±0.12	3.15±0.12	3.22±0.12	3.16±0.12	3.29±0.12	3.22±0.12	3.21±0.12
14-AG	3.40±0.12	3.16±0.12	3.20±0.12	3.26±0.12	3.28±0.12	3.27±0.12	3.27±0.12

2-AG – OPP; 3-AG – *Multibarrier 60 HFP*; 4-AG – *BIALON 50 HFP*; 5-AG-3 –*BIALON 65 HFP*; 6-AG – *ECOLEAN*; 7-AG – PP; 8-AG – *BIO NVS*; 9-AG – *Ceramis®-PLA*; 10-AG – met. *NatureFlex 23NM*;11-AG – *Nativia™ NTSS-30*; 12-AG – *Nativia™ NZSS-20*; 13-AG – met. BOPET/PE; 14-AG – *Aluthen*

Table 5

The dynamics of sherbet sample moisture content in *Mutibarrier 60* film during the storage, %

Samaple	Storagetime, weeks						
	0	2	6	8	12	14	16
G	3.40±0.12	3.17±0.12	2.95±0.11	2.81±0.11	2.55±0.11	2.40±0.10	2.20±0.10
V	3.40±0.12	3.07±0.12	2.66±0.11	2.59±0.11	2.58±0.11	2.43±0.10	2.29±0.10
AG-1	3.40±0.12	2.83±0.11	2.62±0.11	2.54±0.11	2.58±0.11	2.51±0.11	2.43±0.10
AG-2	3.40±0.12	2.83±0.11	2.62±0.11	2.54±0.11	2.58±0.11	2.51±0.11	2.43±0.10
AG-3	3.40±0.12	2.98±0.11	3.25±0.12	2.98±0.11	2.63±0.11	2.62±0.11	2.59±0.11
AG-3-A	3.40±0.12	3.30±0.12	3.05±0.12	2.84±0.11	2.78±0.11	2.78±0.11	2.76±0.11

K – cardboard box; G – air ambience; V – vacuum packaging; AG-1 – 30% CO_2+70% N_2; AG-2 – 70% CO_2+30% N_2; AG-3 – 100% CO_2; AG-3-A – 100% CO_2 + oxygen absorber

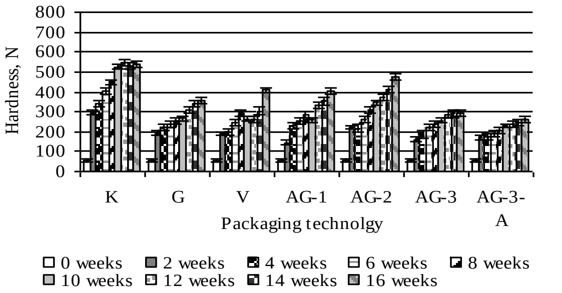

Figure 3. The dynamics of sherbet hardness in Multibarrier 60 HFP material during the storage

K – cardboard box; G – air ambience; V – vacuum packaging; AG-1 – 30% CO_2+70% N_2; AG-2 – 70% CO_2+30% N_2; AG-3 – 100% CO_2; AG-3-A – 100% CO_2 + oxygen absorber

The dynamics of sherbet moisture content during storage in air ambiance and different packaging materials is represented in Table 3. The initial moisture content of sherbet is 3.40±0.12%, which during storage step by step reduces generates hardening of milk pomade confectionary. The highest moisture content decrease in sherbet samples has been observed in air ambiance and cardboard box (1-G) bulk packaging, as well as in cellulose based biodegradable film *BIO NVS* (8-G) packaging. The moisture content of samples in *BIALON* (4-G; 5-G) and *BIO NVS* (8-G) packaging already after 2 weeks decrease up to 2.51–2.82%, and following up the storage till 16 weeks the moisture decreases below 2.03%. Moisture content of samples packed in PP film pouches during 16 weeks decreased up to 2.08±0.10%. The least decrease of moisture content at the same time is observed in OPP (2-G), *Multibarrier 60 HFP*; (3-G) and *ECOLEAN* (6-G) film packed samples, where it reduced till 2.26±0.10%. The dynamics of sherbet moisture content during storage in MAP (100% CO_2) and different packaging materials is represented in Table 4. The influence of biodegradable films is tremendous. Respectively in *BIO NVS* (8-AG-3), *Ceramis®-PLA* (9-AG-3), *NatureFlex 23NM* (10-AG-3); *Nativia™ NTSS-30* (11-AG-3) un *Nativia™ NZSS-20* (12-AG-3) film packaged samples during storage time 16 weeks the moisture content reduced till 1.19±0.10 to 1.28±0.14%. Accordingly better the moisture of samples remained in conventional *BIALON 65 HFP* (5-AG-3) packaging – till 1.71±0.11%, *BIALON 50 HFP* (4-AG-3) –l till 2.03±0.05%, OPP (2-AG-3), *Multibarrier 60 HFP* (3-AG-3), *ECOLEAN* (6-AG-3) and PP (7-AG-3) respectively till 2.35±0.11%, 2.59±0.16%, 2.19±0.08% and 2.49±0.11%. The samples in met. BOPET/PE (13-AG-3) and *Aluthen* (14-AG-3) packaging disparate ($p<0.05$) from all other investigated samples, and the changes in their moisture content during storage are minimal – from initial moisture content 3.40±0.12% till 3.21±0.12% during 16 weeks of storage.

The moisture dynamics of sherbet samples in *Mutibarrier 60 HFP* packaging material with high barrier properties is influenced by various packaging technologies (Table 5). The moisture content of sherbet in cardboard boxes and air ambiance during 16 storage weeks decreased till 1.31±0.08%, while in *Multibarrier60 HFP* packaging and MAP it ranged within 2.20 to 2.76%. Application of packaging materials with high barrier properties could cat down the moisture migration and increase the shelf life of sherbet (Romeo et al., 2010). The verity alike this is expressed in studies of Londhe, Pal and Raju (2012) concerning Asian candies *Peda*, which were packed applying different packaging technologies. As a main problem of *Peda* hardening they consider packaging in air ambiance and cardboard boxes without barriers.

Linear regression analysis affirms that close correlation exists between the sherbet hardness and moisture content apart from the packaging technology and material (Fig. 4). The dynamics of moisture content, in its turn, was affected by the packaging material barrier properties, environment composition within the packaging, and presence of oxygen which could be regulated by the oxygen absorbers (active packaging).

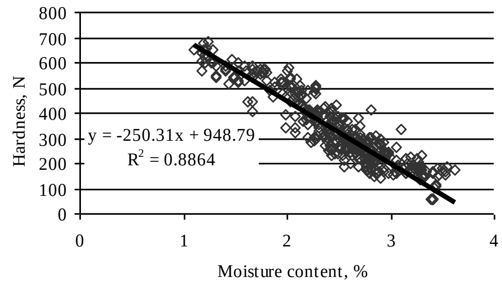

Fig.4. Correlation of the hardness with moisture content of sherbet

Research group under the guidance of scientist Romeo (2010) quoted his authorities and justified linkage among moisture content and hardening of product (Romeo et al., 2010). Regression equation obtained by computerized data processing prove on the fact if product moisture content will be reduced by 1%, the hardness will grow by 250 N. The variance analyses performed of scientists Londhe, Pal and Raju (2012) showed on the moisture content disparity among packaging technologies and storage time. Migration of moisture from the product permeating through packaging to environment could be reduced by selecting appropriate packaging material and conditions (Subramaniam, 2000).

The shelf life of sherbet could be extended significantly using packaging materials with high barrier properties: to 10–12 weeks in OPP and *Multibarrier60 HFP* materials in air ambiance; to 16 weeks in *Multibarrier 60 HFP*, metallised BOPET/PE and *Aluthen* materials in MAP (100% CO_2) ambience; as well as to 16 weeks using oxygen absorbers (active packaging) in metallised BOPET/PE and *Aluthen* materials not exceeding the estimated hardness 300 N. The sherbet hardness in active packaging after 16 weeks in *Multibarrier 60 HFP* was determined 261.18±8.32 N, in metallised BOPET/PE – 146.01±7.54 N and in *Aluthen* – 117.61±8.64 N. By the side of packaging in MAP (100% CO_2), in active packaging it is for 11.5%, 20% and 35.7% less that can be assessed as positive. Biodegradable polymers with improved barrier properties provide a short-time shelf life of sherbet in air ambience maximum to 4 weeks, in MAP (100% CO_2) – to 6 weeks.

The maximum permissible TPC in sugar confectionery sherbet could be ≤4 log CFU g^{-1} (SanPin, 2002). After 16 weeks of storage this level has been exceeded only in samples packed in cardboard boxes and OPP film in air ambiance. Close to this level, aerobic and facultative anaerobic microorganisms grow in biodegradable *Ceramis®-PLA* and *NatureFlex 23NM* packaged sherbet samples. In *Multibarrier 60 HFP*, met. BOPET/PE and *Aluthen* packaging, the growth of microorganisms in sherbet samples occurs more slowly. In experimentally analyzed sherbet samples during the storage time, the number of yeast and mould colony forming units has been estimated. The admissible level of both yeasts and moulds is 50 CFU g^{-1}. In any of the tasted samples throughout the storage time, the number of TPC, yeast and mould colony forming units does not exceed the admissible level.

Conclusions

Linear regression analysis prove a close correlation between the sherbet hardness and moisture content in all the studied packaging types, while the dynamics and intensity of moisture content in the product during the storage time are affected by the packaging material barrier properties.

The desideratum hardness of sherbet is 300 N, which in cardboard box packaging establishes already after two weeks of storage. Shelf life can be extended significantly in conventional polymer packaging with high barrier properties: to 10–12 weeks in air ambience OPP and *Multibarrier 60 HFP* packaging; to 16 weeks in MAP 100% CO_2 and *Multibarrier 60 HFP*, met. BOPET/PE and *Aluthen* material, exceeding neither experts' accepted hardness nor permissible total plate count of microorganisms' level (TPC $g^{-1} \leq 10^4$).

The sherbet hardness in active packaging after 16 weeks of storage in *Multibarrier 60 HFP* is by 11.5% lower than in MAP 100% CO_2, which is valued as positive. Biodegradable polymers with improved barrier properties provide the shelf life of sherbet in air ambience maximum to 4 weeks, in MAP 100% CO_2 maximum to 6 weeks.

References

1. *Ageless Oxygen Absorbing Sachet.* [Accessed on 2.03.2014.]. Available: http://www.conservation-by-design.co.uk/productdetails.aspx?id=404&itemno=SUAGEL1000.
2. Ahvenainen R. (2010) Active and intelligent packaging: An introduction. **In:** *Novel Food Packaging Technologies*. R. Ahvenainen (eds.). Cambridge, U.K: Woodhad Publishing, p. 5–21.
3. Arhipova I., Bāliņa S. (2006) *Statistika ekonomikā un biznesā.* Risinājumi ar SPSS un Microsoft Excel. 2. izdevums. Rīga: Datorzinību Centrs, 364 lpp.
4. Bower J.A. (2009) *Statistica Methods for Food Science: Introductory Procedures for the Food Practitioner*. J.A. Bower (eds.) Oxford, UK; Ames, Iowa: Wiley-Blackwell, 307 p.
5. Brown A.C. (2011) Candy **In:** *Understanding Food: Principles and Preparation*. A.C. Brown (eds). Hardcover: Wadsworth Publishing Company, p. 518–534.
6. Devlieghere F., Debevere J. (2003) MAP, product safetyand nutritional quality. **In:** *Novel Food Packaging Techniques*. R. Ahvenainen (eds). Cambridge, UK: Woodhead Publishing Limited, p. 208–230.
7. Duran A., Tuzen M., Soylak M. (2009) Tracemetalcontents in chewing gums and candies marketed in Turkey. *Environmental Monitoring and Assessment*,Vol. 149, No. 1–4, p. 283–289.
8. Ergun R., Lietha R., Hartel R. W. (2010) Moisture and Shelf Life in Sugar Confections. *Critical Reviews in Food Science and Nutrition*, Vol. 50, Issue 2, p. 162–192.
9. Gibis D., Rieblinger K. (2011) Oxygen scavenging films for food application. *Proceding Food Science*, Vol. 1, p. 229–234.
10. Labuza T., Roe K., Payne C., Panda F. (2004) Storage Stability of Food Systems: Influence of State Changes during Drying and Storage. In: *14th International Drying Symposium*, IDS 2004, SäoPaulo, Brazil, Vol. A, p. 48–68.
11. Lagaron J.M., López-Rubio A. (2010) Latest developments and future trends in food packaging and biopackaging. **In:** *Innovation in Food Engineering New Techniques and Products.* M.L. Passos, C.P. Ribeiro (eds). USA: CRC Press Taylor & Francis Groupp, p. 485–503.
12. Londhe G., Pal D., Raju N. (2012) Effect of packaging techniques on shelf life of brown peda, a milk-based confections. *LWT - Food Science and Technology*, Vol. 47, Issue 1, p. 117–125.
13. Robertson G.L. (2006) *Foodpackaging: principles and practice*. London: CRC Press Taylor & Francis Group, 330 p.
14. RomeoF.V., Luca S.De, Piscopo A., Santisi V., Poiana M. (2010) Shelf-life of almond pastry cookies with different types of packaging and levels of temperature. *Food Science and Technology International*, Vol. 16, Issue 3, p. 233–240.
15. *SanPin, Enactment date of sanitary and epidemiological rules and regulations „Hygienic Requirements for Safety and Nutrition Value of Food Products. Sanitary Rules and Regulations 2.3.2.1078-01"* [Accessed on 12.03.2014]. Available:http://ec.europa. eu/food/international/trade/docs/SanPin2.3.2-1078-01_consolidated
16. Subramaniam P.J. (2000) Confectionery products. **In:** *The Stability and Shelf-Life of Food.* D. Kilcast; P.Subramaniam (eds). Cambridge, England: CRC Press LLC, p. 221–246.
17. Sucharzewska D., Stochmal A., Oleszek W. (2003) The effect of *Yucca schidigera* extract on the physical structure and on the oxidative stability of sugar-candy foam products. *Lebensmittel Wissenschaft und Technologie*, Vol. 36, Iss. 3, p. 347–351.
18. Willis D. (1998) Water activity and its importance in making candy. *Manufacturing Confectioner*, Vol. 78, p. 71–74.