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QUALITY PARAMETERS OF THERMAL PROCESSED INTEGRATED READY TO EAT MEALS

Iveta Kurzemniece[1], Sandra Muizniece-Brasava[1], Lija Dukalska[1], Evita Straumite[1], Valda Kozule[1],
[1]Department of Food Technology, Faculty of Food Technology, Latvia University of Agriculture,
Liela str. 2, LV-3001, Jelgava, Latvia, E-mail: kurzeive@gmail.com

Abstract

The object of this research was the quality investigation of 3 types of thermal processed integrated ready-to-eat meals packed in vacuum using flexible aluminium / polyethylene pouches. Products are evaluated using sensory evaluation tests, which are characterized by product taste, smell, product structure; texture and visual appeal of the product were evaluated.

Key words: *ready to eat meals, quality parameters, sensory analysis*

1. INTRODUCTION

Accelerate pace of life is becoming pressing need for ready to eat meals, which also would have adequate nutritional value. The growth of world consumption of meat and meat products is noteworthy, not only for its scale but also for its constancy. Consumption has developed around more elaborate products incorporating two types of service: a saving of preparation time ('ready-to-eat' food) and a diversification of places of consumption (catering outside the home), (Valceschini 2006).

Ready to eat meals can be broadly defined as complex assemblages of precooked foodstuffs, packaged together and sold through the refrigerated retail chain in order to present the consumer with a rapid meal solution (Spenser 2005). Consumption of ready-to-eat meals is limited, because more or less people prefer traditions and could be applied for home consumption or foodservice/catering. Results of some researches show that some preferences are linked with tradition, whereas others are more innovative and typical of modern-time behaviour (Feliciano 2006).

Ready to eat traditionally cooked dishes can not be stored for a long time. One of the most effective ways of preparation of such products is heat treatment, followed by storage under reduced temperature. Although currently the world's food sterilization is already well known and popular cooking method, however, each type of product it is applied in the evaluation of the product specificity of the chemical composition. Ready to eat products need a preservatives or mild pasteurization to give them a commercially acceptable shelf life. Nowadays, a perspective method to extend the shelf life of food products is vacuum packaging and packaging in the protective gas mixture or modified atmosphere (MAP), (Devlieghere 2000; Spenser 2005); days or weeks, maintaining food quality, taste, and aroma.

The development of the latest packaging technology ever more relevant place of food quality preservation during storage they occupy the packaging material. Very important is packaged product compatibility with packaging materials, so the correct choice of packaging is one of the ways to maintain maximum product quality, while maintaining the nutritional value of the product.

There are great variances of packaging products for cooked meals and beverages. These options include unit-portion packs, vacuum barrier bags, trays for frozen and chilled meals, flexible pouches

and “bag-in-a-box” products (Brody, 2003), disposable heat-resistant bags for cooking and hot-holding, as well as self-heating containers (heat generating reaction of calcium oxide and water). Prevention of recontamination of food, convenience and minimisation of waste, more storage space and less labour costs are just some of the benefits of packaging (Olsson 2004).

Innovation include faster and better preparation methods, improved temperature control, even heating, energy and labour savings, less waste, better sanitation, faster service and flexibility. Novel food service processes can evolve as a result of adoption of technological breakthroughs in “high tech” fields of the economy. This justifies investments in offensive research and highlights the importance of technical competencies for a food service professional (Rodgers 2007).

A sensory aspect of consumer choices for meat and meat products is still highly influenced by the perception of its healthiness, safety, tenderness, juiciness and aroma or flavour.

The stability of the proximate composition (moisture, proteins, lipids and ash) and the microbiological state of cooked ‘ready to eat’ foods in vacuum or modified atmosphere packaging were examined and compared with conventionally packaged (in air) foods. Vacuum or modified atmosphere packaging was effective for prolonging the shelf-life of the studied products up to 29 days with minimal changes in the proximate composition. Aerobic mesophilic, psychrotrophic microorganisms, and yeasts and moulds increased with time regardless of packaging type but more rapidly under conventional packaging (Murcia 2003).

Vacuum packaging prevents evaporative losses of flavour volatiles and moisture during cooking and inhibits off-flavors from oxidation (Church and Parsons 2000). This results in especially flavourful and nutritious food (Church 1998). Heat treated food to reduce both the vegetative microorganisms and the spores to a safe level are called sterilization. [Sterilization is typically achieved by using a pressure cooker to heat the center of the food to +250 °F (+121 °C) for 2.4 minutes (Snyder 2006). Sterilized foods are shelf stable, but are grossly overcooked and taste similar to canned foods.] (Baldwin 2008).

A new method of vacuum packaging food products is utilizing a vacuum and seal following a blanch and achieving a combination of heat and reduced pressure which causes a critical point or boiling point of water, resulting in microbial kill in excess of that achieved by the blanch alone and significantly enhancing shelf life and safety of the food products (United States Patent 4933411).

The sensory quality of food comes from the combination of a set of parameters concerning all the steps of product life, from the raw materials to the conditions of preparation (Curt 2004). Sensory analysis is one of the main quality indices in shelf-life and storage studies for foods, especially for products which are microbiologically stable such as heat stable meals (Nuin 2008). Quality assessments including sensory evaluation, nutritive value, organoleptic properties, processing and product traceability; and quality indicators that may be useful to the consumers when buying milk and meat products (Hocquette 2005).

Microorganisms (bacteria, yeasts, moulds, viruses, etc.) are living entities too small to be seen by the naked eyes. The intrinsic and extrinsic parameters of foods related to microbial spoilage and control of vegetables, fruits, meats, poultry, eggs, seafood, fish and shellfish, sugar, spices, beer, wine, and other food commodities are discussed. Food preservation methods such as drying, dehydration, lyophilisation, low temperatures (cooling, chilling, refrigeration, freezing, and thawing), and high temperatures (heating, pasteurization, sterilization, and canning) are discussed. The importance and use of alpha, beta, gamma rays, electronic beams irradiation, UV, and microwave treatments as well as food-grade chemicals against microorganisms in foods and fermentation are explored (Fung 2009).

The safety of meat has been at the forefront of societal concerns in recent years, and indications exist that challenges to meat safety will continue in the future. Major meat safety issues and related challenges include the need to control traditional as well as "new," "emerging," or "evolving" pathogenic microorganisms, which may be of increased virulence and low infectious doses, or of resistance to antibiotics or food related stresses. Viral pathogens will continue to be of concern at food service, bacterial pathogens such as *Escherichia coli O157:H7*, *Salmonella* and *Campylobacter* will continue affecting the safety of raw meat and poultry, while *Listeria monocytogenes* will be of concern in ready-to-eat processed products (Sofos 2008).

Meat and meat products may be contaminated with *Pseudomonas*, *Enterobacteriacea* and *lactic acid bacteria*, *Listeria monocytogenes*, *Salmonella typhimurium*, *Salmonella enteritidis*, *Escherichia coli* and *Yersinia enterolitica*, responsible for food-borne illnesses and deaths. In addition to the development of pathogens, microbial growth commonly induces undesirable organoleptic changes during the storage of meat (Marcos 2007).

Bioactive packaging technologies extended shelf life of meat-based products and spread of spoilage and pathogenic microorganisms. Antimicrobial packaging include systems such as adding a sachet into the package, dispersing bioactive agents in the packaging, coating bioactive agents on the surface of the packaging material, or utilizing antimicrobial macromolecules with film forming properties or edible matrices. The potential of these technologies are evaluated for the preservation of meat and meat products (Coma 2008).

There are some researches of antimicrobial activity of several herbs and spice extracts from honeysuckle, Scutellaria, Forsythia suspense (Thunb), cinnamon, and rosemary with 75% ethanol and from clove oil dissolved in 75% ethanol were applied to inoculated agar media to observe their inhibitory effects on the growth of *Escherichia coli*, *Pseudomonas fluorescens*, and *Lactobacillus plantarum.* All the extracts suppressed the growth of these bacteria. That combined herb and spice extracts can be used as natural antimicrobials for food preservation (Kong 2007).

Microbiological Safety of retail modified-atmosphere-packed and vacuum-packed cooked ready-to-eat meats to determine the microbiological quality at the end of shelf life and to establish any risk factors in the production, storage, and display of this product. All samples at the end of the shelf life had satisfactory (<20 CFU/g) and/or acceptable ($<10^2$ CFU/g) levels of *Staphylococcus aureus* and *Clostridium perfringens*, four samples (<1%) had unsatisfactory levels of *Escherichia coli* (range of 10^2 to 10^6 CFU/g) and 5.5% of the samples contained *L. monocytogenes Salmonella* was not detected in any samples examined. Risk factors identified for cooked meats that were microbiologically contaminated more frequently included vacuum packaging, packaging on retail premises, slicing, temperature not monitored in display units, and no hazard analysis system in place (Sagoo 2007).

Shelf life evaluation for ready-to-eat sliced uncured turkey breast and cured ham. The growth variability of three *Listeria monocytogenes ribotypes* in ready-to-eat (RTE) sliced uncured turkey breast and cured ham was studied under storage conditions that RTE foods are likely to encounter. Significant effect of strain difference was noted in both sliced products (Pal 2008).

The aim of this study was to investigate the quality of 3 types of integrated and thermal processed ready-to-eat meals packed under vacuum using flexible aluminium / polyethylene pouches and metal cans. Products are evaluated using sensory evaluation tests, which are characterized by product taste, smell, product structure, texture and visual appeal of the products were evaluated.

2. MATERIALS AND METHODS

Experiments have been carried out at the Latvia University of Agriculture Department of Food Technology.

2.1. Food samples and packaging

The object of research is – canned ready to eat meals. The characteristics of 3 types of integrated and thermal processed ready-to-eat meals packed under vacuum using flexible Al/PE film pouches is demonstrated in the Fig.1 and in metal cans – in Fig.2.

Vacuum packed ready to eat meals were placed in flexible Al/PE film (ALUTHEN) pouches with barrier properties by thickness 20/45 μm with size of 150 x 200 mm and sealed by chamber type machine MULTIVAC A 300/16. Metal cans with diameter 96 mm and height 32 mm were used, packed and sealed at the real conditions of production. All samples were sterilized in autoclave 20 min at temperature +121±0.5 °C. Mass of each sample was 250±1 g. Samples packed in flexible Al/PE film after thermal processing were stored at room temperature +20±0.5 °C within 2 months. Five identical samples were examined by sensory evaluation and microbiological analyses immediately after production and after 2 months of storage.

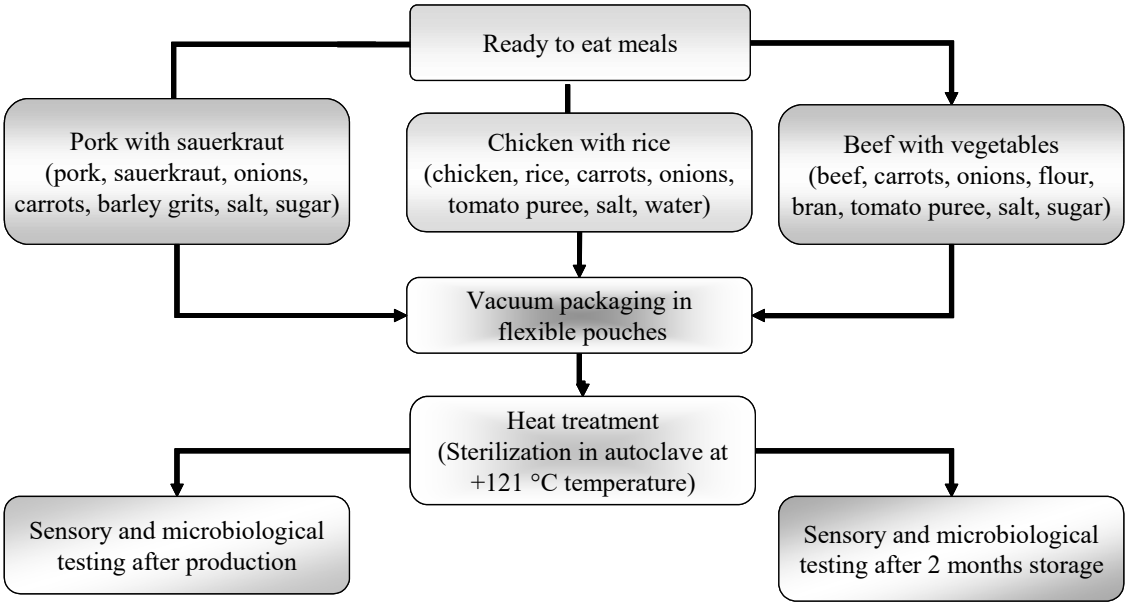

Fig.1. The characteristics of 3 types of integrated and thermal processed ready-to-eat meals packed under vacuum using flexible Al/PE film.

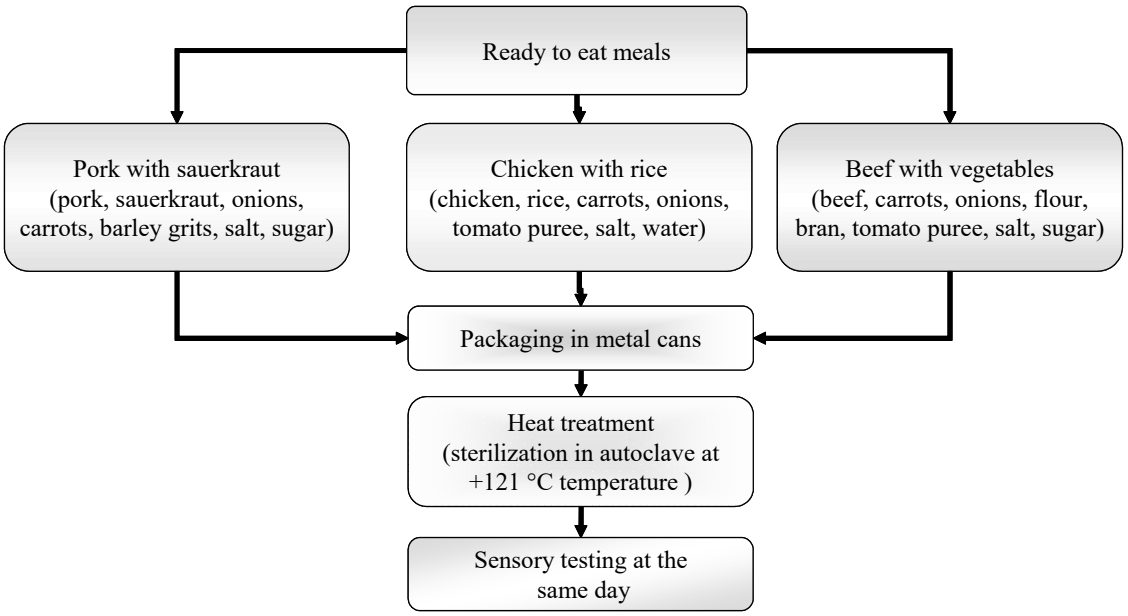

Fig.2. The characteristics of 3 types of integrated and thermal processed ready-to-eat meals packed in metal cans.

2.2. Sensory evaluation

Sensory analysis of the ready to eat meals was carried out; samples were prepared by integrated prescription, determined by nutritional value. Nine sensory evaluated samples are characterized in Table 1.

Table 1. Sensory tested and evaluated ready to eat meal samples.

Samples	Deciphering of samples
A	chicken with rice in the flexible package
B	chicken with rice in the metal can
C	chicken with rice in the flexible package after 2 storage months
D	pork with sauerkraut in the flexible package
E	pork with sauerkraut in the metal can
F	pork with sauerkraut in the flexible package after 2 storage months
G	beef with vegetables in the flexible package
H	beef with vegetables in the metal can
I	beef with vegetables in the flexible package after 2 storage months

The quality of products was evaluated using a 5-point scale – visual appearance, texture, taste and smell was measured. Sensory properties of each sample were evaluated by 5 points: 5 – the quality is very good, while 1 – inadequate quality. The maximum total scores, that can get product with very

good quality, are 20 points. In the evaluation took part 20 trained panellists at the age of 25 to 60 years.

The obtained results were processed by mathematical and statistical data processing methods, using analysis of variance ANOVA and Tukey's test (Castura, Findaly 2006).

2.3. Microbiology

Samples packaged in flexible packs were microbiologically tested immediately in the same day after sterilization and cooling and after two months storage at temperature +20±0.5 °C. Three samples for determination of the total count of micro-organisms were prepared in accordance with the standard LVS-ISO 6887-2 and ISO 6887-1. Mesophilic aerobic and optionally anaerobic microorganisms were determined in accordance to the standard LVS EN ISO 4833:2003 "Food and animal feed stuffs." Intestinal wand group of bacteria (*Escherichia coli*) was determined according to standard LVS ISO 16649-2:2001 "Food and animal feed stuffs." Samples were inoculated in addition to *Pseudomonas* and *Bacillus* group of bacteria (principles 1997).

3. RESULTS AND DISCUSSION

3.1. Sensory evaluation of the chicken with rice samples

The evolution results of prepared meal – the quality indices of chicken with rice smell (Table 2), taste (Table 3), consistency (Table 4) and visual appearance (Table 5) are summarized in Figure 3.

The results of variance analysis (ANOVA) of smell evaluation for flexible and in metal cans packed chicken with rice in a moment after processing as well as after 2 months storage at room temperature +20±0.5 °C in flexible packaging are demonstrated in Table 2.

Table 2.The results of variance analysis (ANOVA) for chicken with rice smell evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	5.65	19	0.30	0.80	0.69	1.87
Samples	1.23	2	0.62	1.66	0.20	3.25
Error	14.10	38	0.37			
Total	20.98	59				

$p \leq 0.05$

The results of the analysis of variance of smell for chicken with rice $F_{calculated}=1.66<F_{critical}=3.25$ show that there are not significant differences between the smell of chicken with rice samples.

The results of variance analysis (ANOVA) of taste evaluation of flexible and in metal cans packed chicken with rice in a moment after processing as well as after 2 months storage in flexible packaging are demonstrated in Table 3.

Table 3. The results of variance analysis (ANOVA) for chicken with rice taste evaluation.

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	18.98	19	0.99	1.37	0.20	1.87
Samples	26.23	2	13.12	17.95	3.25E-06	3.25
Error	27.77	38	0.73			
Total	72.98	59				

$p \leq 0.05$

The results of the analysis of variance of taste for chicken with rice $F_{calculated}=17.95>F_{critical}= 3.25$. show that there are significant differences between the tastes of chicken with rice samples. Tukey's test results show that the panellists evaluated as the best samples A (chicken with rice in the flexible packaging) and B (chicken with rice in the metal can package), after that sample C (chicken with rice in the flexible packaging after 2 month storing) sample. The storage time reduces the quality of the estimated sample.

The results of variance analysis (ANOVA) of consistency evaluation of flexible and in metal cans packed chicken with rice after processing as well as after 2 months storage in flexible packaging are demonstrated in Table 4.

Table 4. The results of variance analysis (ANOVA) for chicken with rice consistency evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	22.40	19	1.18	1.56	0.12	1.87
Samples	4.63	2	2.32	3.07	0.06	3.25
Error	28.70	38	0.76			
Total	55.73	59				

$p \leq 0.05$

The results of the analysis of variance of consistency for chicken with rice $F_{calculated}=3.07<F_{critical}=3.25$ show that there is not significant difference between the consistency of chicken with rice samples.

The results of variance analysis (ANOVA) of visual appearance evaluation of flexible and in metal cans packed chicken with rice after processing as well as after 2 months storage in flexible packaging are demonstrated in Table 5.

Table 5. The results of variance analysis (ANOVA) for chicken with rice visual appearance evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	11.25	19	0.59	1.62	0.10	1.87
Columns	2.10	2	1.05	2.87	0.07	3.25
Error	13.90	38	0.37			
Total	27.25	59				

$p \leq 0.05$

The results of the analysis of variance of visual appearance for chicken with rice $F_{calculated}=2.87<F_{critical}=3.25$ show that there is not significant difference among between the visual appearance of chicken with rice samples.

The evolution results of prepared meal quality indices containing rice and chicken are summarized in the Figure 3. Samples packaged in flexible pouches (sample A) and metal cans (sample B) were evaluated on the first day after thermal treatment, flexible packed samples (sample C) were evaluated after two months of storage at room temperature +20±0.5 °C as well.

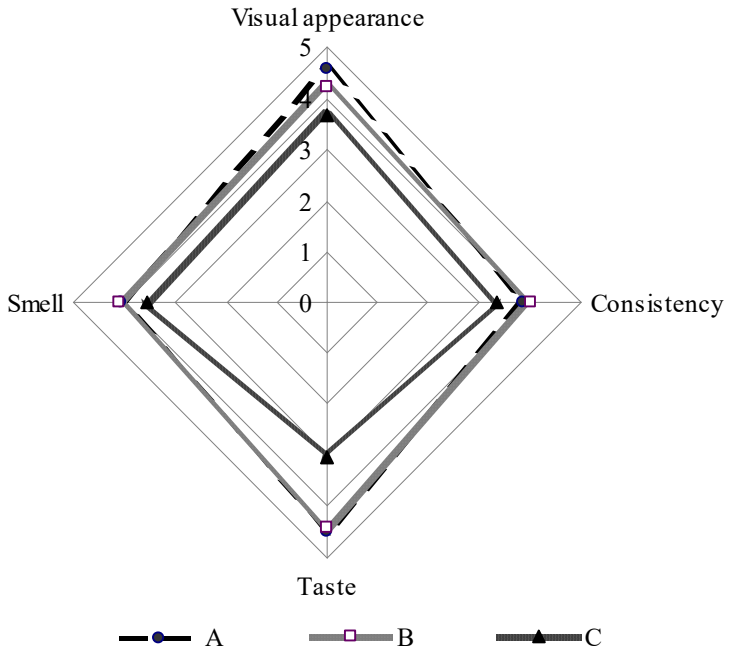

Fig.3. Sensory properties of the ready to eat meal – rice with chicken in 5-point scale.

3.2. Sensory evaluation of the pork with sauerkraut samples

The evolution results of prepared meal – pork with sauerkraut quality indices: smell (Table 6), taste (Table 7), consistency (Table 8) and visual appearance (Table 9) are summarized in Figure 4.

The results of variance analysis (ANOVA) of smell evaluation of flexible and in metal cans packed pork with sauerkraut immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 6.

Table 6. The results of variance analysis (ANOVA) for pork with sauerkraut smell evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	24.40	19	1.28	1.33	0.22	1.87
Samples	18.63	2	9.32	9.65	0.01	3.25
Error	36.70	38	0.97			
Total	79.73	59				

$p \leq 0.05$

The results of the analysis of variance of smell for pork with sauerkraut $F_{calculated}=9.65>F_{critical}=3.25$ show that there are significant difference between the smell of pork samples with sauerkraut. Tukey's test results show that the panellists liked better sample D (pork with sauerkraut in the flexible packaging) after that sample E (pork with sauerkraut in the metal can packaging) and the lowest

assessment was for sample F (pork with sauerkraut in the flexible packaging after 2 month storing) sample. The storage time and type of packaging reduces the smell quality of the estimated samples.

The results of variance analysis (ANOVA) of taste evaluation of flexible and in metal cans packed pork with sauerkraut immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 7.

Table 7. The results of variance analysis (ANOVA) for pork with sauerkraut taste evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	13.07	19	0.69	1.74	0.07	1.87
Samples	49.63	2	24.82	62.73	9.14E-13	3.25
Error	15.03	38	0.40			
Total	77.73	59				

$p \leq 0.05$

The results of the analysis of variance of taste for pork with sauerkraut $F_{calculated}=62.73>F_{critical}=3.25$ show that there are significant differences between the smell of pork with sauerkraut samples. Tukey's test results show that the panellists liked better the sample D (pork with sauerkraut in the flexible packaging) after that sample E (pork with sauerkraut in the metal can packaging) and the lowest assessment was for sample F (pork with sauerkraut in the flexible packaging after 2 month storing) sample. The storage time and type of packaging reduces the taste of the estimated samples.

The results of variance analysis (ANOVA) of consistency evaluation of flexible and in metal cans packed pork with sauerkraut immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 8.

Table 8. The results of variance analysis (ANOVA) for pork with sauerkraut consistency evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	12.85	19	0.67	0.80	0.69	1.87
Samples	19.23	2	9.62	11.38	0.01	3.25
Error	32.10	38	0.85			
Total	64.18	59				

$p \leq 0.05$

The results of the analysis of variance of consistency for pork with sauerkraut $F_{calculated}=11.38>F_{critical}=3.25$ show that there are significant differences between the consistency of pork with sauerkraut samples. All investigated samples of pork with sauerkraut mutually differ in consistency. Tukey's test results show that the panellists liked better the sample D (pork with sauerkraut in the flexible packaging), the next sample E (pork with sauerkraut in the metal can packaging) and the lowest assessment was for sample F (pork with sauerkraut in the flexible packaging after 2 month storing) sample. The storage time and type of packaging reduces the consistency of the estimated samples.

The results of variance analysis (ANOVA) of visual appearance evaluation of flexible and in metal cans packed pork with sauerkraut immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 9.

Table 9. The results of variance analysis (ANOVA) for pork with sauerkraut visual appearance evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	9.27	19	0.49	0.72	0.76	1.87
Samples	8.93	2	4.47	6.60	0.01	3.25
Error	25.73	38	0.68			
Total	43.93	59				

$p \leq 0.05$

The results of the analysis of variance of visual appearance for pork with sauerkraut $F_{calculated}=6.60>F_{critical}=3.25$ show that there are significant differences between the visual appearance of pork with sauerkraut samples. Tukey's test results show that the panellists better liked the sample D (pork with sauerkraut in the flexible packaging) the next sample E (pork with sauerkraut in the metal can packaging) and the lowest assessment were for sample F (pork with sauerkraut in the flexible packaging after 2 month storing) sample. The storage time and type of packaging reduces the visual appearance of the estimated samples.

The evolution results of prepared meal quality indices containing sauerkraut and pork are presented in the Figure 4. Samples packaged in flexible pouches (sample D) and metal cans (sample E) were evaluated immediately on the first day after thermal treatment, flexible packed samples (sample F) were evaluated after two months of storage at room temperature +20±0.5 °C as well.

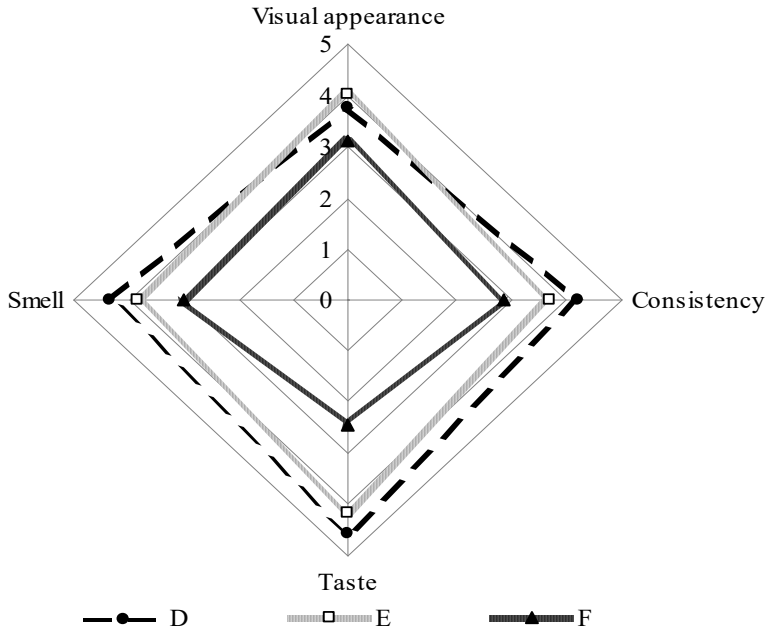

Fig. 4. Sensory properties of the ready to eat meal – sauerkraut with pork in 5-point scale.

3.3. Sensory evaluation of the beef with vegetables samples

The evolution results of prepared meal – beef with vegetables quality indices: smell (Table 10), taste (Table 11), consistency (Table 12) and visual appearance (Table 13) are summarized in Figure 5.

The results of variance analysis (ANOVA) of smell evaluation of flexible and in metal cans packed beef with vegetables immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 10.

Table 10. The results of variance analysis (ANOVA) for beef with vegetables smell evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	21.92	19	1.154	1.13	0.36	1.87
Samples	2.03	2	1.017	1.00	0.38	3.25
Error	38.63	38	1.02			
Total	62.58	59				

$p \leq 0.05$

The results of the analysis of variance of smell for beef with vegetables $F_{calculated}=1.00<F_{critical}=3.25$ show that there does not exist a significant difference between the smell appearance of beef with vegetables samples.

The results of variance analysis (ANOVA) of flexible and in metal cans packed beef with vegetables taste evaluation immediately after processing as well as of flexible packed sample after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 11.

Table 11. The results of variance analysis (ANOVA) for beef with vegetables taste evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	15.27	19	0.80	1.27	0.26	1.872
Samples	11.2	2	5.60	8.82	0.01	3.25
Error	24.13	38	0.64			
Total	50.60	59				

$p \leq 0.05$

The results of the analysis of variance of taste for beef with vegetables $F_{calculated}=8.82>F_{critical}=3.25$ show that there are significant differences between the taste of beef with vegetables samples. All investigated samples of beef with vegetables mutually differ in consistency. Tukey's test results show that the panellists liked better sample G (beef with vegetables in the flexible packaging) the next sample H (beef with vegetables in the metal can packaging) and the lowest assessment was for sample I (beef with vegetables in the flexible packaging after 2 month storing) sample. The storage time and type of packaging reduces the taste of the estimated samples.

The results of variance analysis (ANOVA) of flexible and in metal cans packed beef with vegetables consistency evaluation immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 12.

Table 12. The results of variance analysis (ANOVA) for beef with vegetables consistency evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	7.93	19	0.42	0.69	0.80	1.87
Samples	9.03	2	4.52	7.47	0.01	3.25
Error	22.97	38	0.61			
Total	39.93	59				

$p \leq 0.05$

The results of the analysis of variance of consistency for beef with vegetables $F_{calculated}=7.47>F_{critical}=3.25$ show that there are significant differences between the consistency of beef with vegetables samples. All investigated samples of beef with vegetables mutually differ in consistency. Tukey's test results show that the panellists better liked sample G (beef with vegetables in the flexible packaging) the next sample H (beef with vegetables in the metal can packaging) and the lowest assessment was for sample I (beef with vegetables in the flexible packaging after 2 month storing) sample. The storage time and type of packaging reduces the consistency evaluation of the estimated samples.

The results of variance analysis (ANOVA) of flexible and in metal cans packed beef with vegetables visual appearance evaluation immediately after processing as well as of flexible packed samples after 2 months storage at room temperature +20±0.5 °C are demonstrated in Table 13.

Table 13. The results of variance analysis (ANOVA) for beef with vegetables visual appearance evaluation

Source of Variation	SS	df	MS	F	P-value	F crit
Panellists	10.18	19	0.54	0.94	0.54	1.87
Samples	2.43	2	1.22	2.14	0.13	3.25
Error	21.57	38	0.57			
Total	34.18	59				

$p \leq 0.05$

The results of the analysis of variance of visual appearance for beef with vegetables $F_{calculated}=2.14<F_{critical}=3.25$ show that there does not exist a significant difference between the visual appearance of beef with vegetables samples.

The evolution results of prepared meal quality indices containing beef with vegetables are summarized in the Figure 5. Samples packaged in flexible pouches (sample G) and metal cans (sample H) were evaluated on the first day after thermal treatment, while flexible packed samples (sample I) were evaluated after two months of storage at room temperature +20±0.5 °C as well.

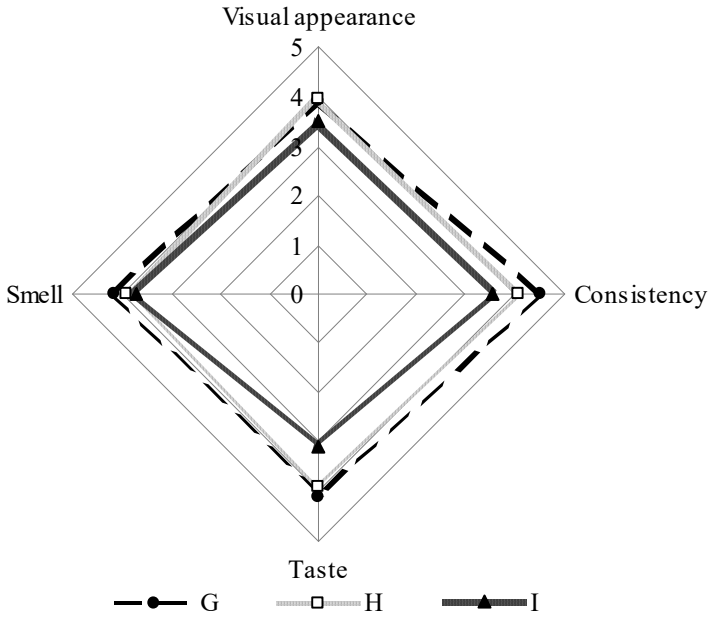

Fig. 5. Sensory properties of the the ready to eat meal – beef with vegetables in 5-point scale.

3.4. Total score of investigated sample sensory properties

After the evaluation of individual quality parameters of all investigated products, total scores of sensory properties providing information about product quality were mathematically calculated. The obtained results are summarized in Figure 6.

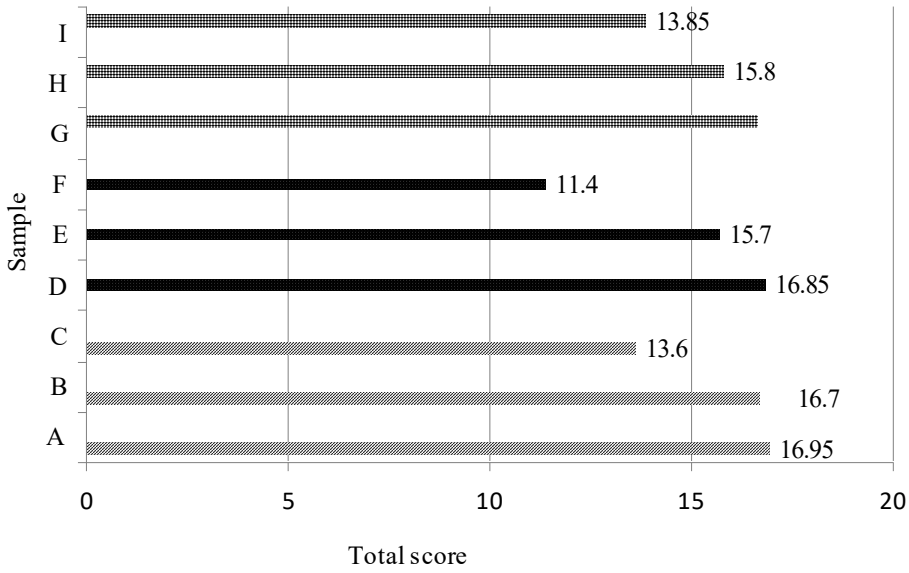

Fig. 6. The total point number of properties for sensory evaluated samples:

A – chicken with rice, flexible packing; B – chicken with rice, metal cans; C – chicken with rice, flexible packing after 2 months storage; D –- sauerkraut with pork flexible packing; E – sauerkraut with pork, metal cans, F – sauerkraut with pork flexible packing after 2 months storage; G – beef with vegetables, flexible packing; H – beef with vegetables, metal cans; I – beef with vegetables, flexible packing after 2 months storage.

Mathematical processing of obtained data provides that the total score of sensory properties for ready to eat meals in flexible packing tested on the first day after thermal treatment is 17, which corresponds to assessment – a very good quality. The sensory evolution of samples packed in metal cans is different. Sample chicken with rice was evaluated with 17 points, which corresponds to the description of very good quality, but the sauerkraut with pork and beef with vegetables is assessed with 16 points, corresponding to the description of good quality. By contrast, for 2 months stored samples the rating is 14, which means good-quality for samples of chicken meat with rice and beef with vegetables, but the assessment for sample sauerkraut with pork is 11 correspond to the description - medium quality.

In response, it can be concluded that among all the investigated samples with respect to packaging type, there does not exist a significant difference in total point number of sample properties after processing. For its part the quality of all investigated samples decreased after 2 months storage.

3.5. Microbiology

To confirm that the thermal process (sterilization) has reached the choice target, as well as to develop an appropriate sterilization formula, microbiological testing of samples was carried out. All samples were tested in accordance with the guidelines (2007) pointed parameters by checking the microbiological compliance of our products to ready to eat meal group. All microbiologically tested samples on the first day after thermal treatment were not microbiological contaminated. From the microbiological point of view samples were purely because there was not detected presence of any micro organisms not after processing, not even after two months of storage at temperature +20 ±0.5 °C. Samples regarding microbiological criteria are considered appropriate, since it was detected only in minor quantities *Pseudomonas* bacteria, other micro-organisms in the presence was not detected.

CONCLUSIONS

All evaluated samples have been assessed very well. The highest sensory evaluation rating got sample chicken with rice sample, slightly below was evaluated the sample beef with vegetables and the lowest appreciation has sample sauerkraut with pork.

In response, it can be concluded that among all the investigated samples with respect to packaging type, there does not exist a significant difference in total point number of sample properties after processing. For its part the quality of all investigated samples decreased after 2 months storage.

The studied proofed those microbiological indicators of freshly produced products, as well as of two-month at temperature +20 ±0.5 °C stored samples correspond to standard.

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