DEVELOPMENT OF READY TO EAT MEALS WITH HIGH NUTRITIONAL VALUE

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Abstract

Modern lifestyle has fundamentally changed eating habits around the world, leading to a substantial increase in demand for ready to eat meals, therefore, these meals have a significant impact on consumer health. A balanced nutritional formulation of ready to eat meals is especially important because the intake of fat within European population is high, while carbohydrate intake low. Ready to eat meals, which are available on the market at the moment, often contain too much sugar, salt and fat, while dietary fibre in these meals can be found in considerably small quantities. Dietary fibre plays an important role in various physiological processes and can prevent the risk of several diseases. The study aims to develop enjoyable food products with high fibre content and search for alternative sources of fibre to improve the nutritional value of new foods.

Five types of ready to eat meals were prepared for this study: potatoes, potatoes with chicken fillet, potatoes with amaranth, potatoes with quinoa, and potatoes with bulgur. Ready to eat meals were filled in laminated polyethylene terephthalate / aluminium / polyamide / polypropylene (PET/ALU/PA/PP) pouches, hermetically sealed under vacuum and thermally treated at 120 ± 0.5 °C for 10 minutes. After processing, fibre content, moisture and hardness was determined in all ready to eat meal samples.

The results showed that adding fibre-rich ingredients to potatoes increases the functionality of ready to eat meals.

Key words: *ready to eat meals, nutrition, fibre*

1. INTRODUCTION

Two trends can be observed in Europe today. First, consumers eat more convenience food than ever. Secondly, there is a significant increase in European consumers with excess weight. Convenience food is defined as any fully or partially prepared foods in which significant preparation time, culinary skills, or energy inputs have been transferred from home kitchen to the food processor or distributor. Convenience meals are often perceived as unhealthy food choices (Olsen et. al., 2012).

Ready meals can be defined as pre-prepared, chilled or frozen foods, which do not need additional ingredients and require minimal preparation prior to use (Regueiro, Wenzl, 2015). At present, about 63% of ready to eat meals in the European market contain meat (40% chicken, 30% pork and 30% beef), 16% contain meat products such as sausages or bacon, 16% contain fish (salmon, catfish) and only 6% of ready to eat meals are vegetarian. Most commonly used starch-containing ingredients in ready meals are rice (41%), potatoes (22%), noodles (22%) and dumplings (16%) (Kanzler et al., 2015).

Dietary fibre can be considered as functional food. Due to the nature of fibre having both insoluble and soluble properties, it has a range of technological attributes such as water binding, gelling, and structure building and it can be used as a fat replacer (O'Shea et al., 2012). Products with addition of fibre are able to bind more water and that provides longer storage time (Hong et al., 2012). There is an increasing demand for old cultivated crops such as amaranth (*Amaranthus caudatus*) and quinoa (*Chenopodium quinoa*). They are high in fibre, bioactive compounds and high quality protein, therefore they are considered health-promoting food (Hejazi et al., 2016; Diaz et al., 2015; Lamothe et al., 2015). Amaranth is a functional food alternative for coeliac patients, it has antioxidant, antithrombotic, and anti-diabetic properties (Barrio, Anon, 2010; Moronta et al., 2016). Amaranth can be used to improve the nutritional value of food products (Chauhan et. al., 2015). Quinoa is gaining popularity as a functional food similar to amaranth; dietary fibre content in quinoa is equal to cereals

and leguminous seeds (Lamonthe et al., 2015; Graf et al., 2014). Bulgur, on the other hand, is one of the traditional durum wheat products in Turkey and the Middle East, with a growing demand in the developed and the developing countries (Savas, Basmane, 2016). Bulgur is a functional wheat product, available in the market as a ready (ready to eat) or a semi-ready (half-ready to eat) product, which is used in more than 250 different meals (pilaf, soups, salads, etc.) (Erbaş et al., 2016; Yildirim et al., 2008). Bulgur is an important source of fibre and contains 18.3 g fibre per 100 g (Erbaş et al., 2016).

Nowadays, consumers pay more attention to a healthy diet and lifestyle, therefore, the demand for functional foods that contain biologically active compounds is ever increasing (Erbaş et al., 2016; Diaz et al., 2015; Hong et al., 2012; O'Shea et al., 2012). Fibre rich functional foods can help prevent a variety of health problems. Fibre acts as an adsorbent in the body, it can help reduce glucose absorption rate and maintain stable blood sugar levels after meals, reduce the risk of high blood pressure and heart diseases, prevent constipation, and reduce total blood cholesterol (Hong et al., 2012; O'Shea et al., 2012). Increase in fibre consumption can reduce glycaemic response in the body. Insoluble fibre inhibits α-amylase activity, hinders the diffusion of glucose, and reduces glucose concentration by absorbing it. The effect of fibre depends on the origin and composition of fibre and food. Water-insoluble fibre from wheat bran are the most effective in retarding α-amylase activity (Qi et al., 2016).

Food scientists need to develop enjoyable food products with high fibre content and continue the search for alternative sources of fibre to improve the nutritional value of new foods (Lamothe et al, 2015).

2. MATERIALS AND METHODS

Experiments were carried out at the laboratories of Faculty of Food Technology, Latvia University of Agriculture.

A total of five ready to eat meals thermally processed in packaging were studied in this research – potatoes, potatoes with chicken fillet, potatoes with amaranth, potatoes with bulgur and potatoes with quinoa.

Peeled potatoes (*Solanum tuberosum* L. cv. Gala) were cut in 10x10 mm cubes by cutter *Robot Coupe CL50*. Cut potatoes were mixed with fibre-rich ingredients (quinoa, bulgur and amaranth) and chicken fillet. The ingredients of ready to eat meals are summarized in Table 1.

Table 1. Formulation of ready to eat meals

Samples	Potatoes, %	Functional ingredients, %			Chicken fillet, %	Salt, %
		Quinoa	Amaranth	Bulgur		
Sample 1	99.5	--	--	--	--	0.5
Sample 2	66.5	33.0	--	--	--	0.5
Sample 3	66.5	--	33.0	--	--	0.5
Sample 4	66.5	--	--	33.0	--	0.5
Sample 5	49.5	--	--	--	50.0	0.5

After mixing, products (300±10 g) were filled in PET/ALU/PA/PP pouches with aluminium layer (laminated pouches of 200x250 mm with 110 µm thickness). After filling, pouches of ready to eat meals were hermetically sealed using chamber type vacuum packaging machine *Multivac C350*, hermetic sealing mode – vacuum, 20 MPa, sealing time – 5 seconds. Vacuum sealed pouches were then thermally treated in a pilot autoclave *HST 50/100, ZIRBUS Technology GmbH* (Germany).

Sterilization was carried out at 120 ± 2 °C for 10 min, the cooling temperature was 20 ± 2 °C. After thermal treatment, fibre content, moisture and hardness was determined in all ready to eat meal samples.

Determination of fibre content

Total dietary fibre content in ready to eat meals was determined according to ISO 5498 standard method with „Fibertec system 1010 Heat Extractor" (Foss, Denmark). Extraction system is designed for the determination of fibre, refined fibre, cellulose, hemicellulose and lignin. Measurements were carried out in triplicate.

Determination of moisture content

Moisture content in ready to eat meals was determined with moisture analyser "Precisa XM 120". Moisture content was determined by heating product samples at + 110 °C to constant weight, moisture content was read when 3 measurements remained the same after every 20 seconds. Sample size for moisture analysis was 3.00 ± 0.01 g. After drying, moisture content (%) of the sample was read on the display of moisture analyser. Measurements were carried out with three identical samples of each ready to eat meal.

Determination of hardness

Hardness of ready to eat meal samples was analysed with "TA.XT.plus Texture Analyser" (Stable Micro Systems Ltd., Surrey, UK) with the measuring probe A/MPP (Multiple Puncture Probe). Measuring parameters for sample hardness were following: pre-test speed 1 mm s^{-1}; test speed 2 mm s^{-1}; post-test speed 10 mm s^{-1}; penetrating distance 50 mm into the sample. Measurement was triggered automatically at 30 g. The system was equipped with a 50 kg compression cell and software Texture Exponent 32. Hardness was measured as the maximum penetration force (N) reached during tissue breakage. The maximum force required for sample compression was calculated as an average of 5 measurements with the precision of the standard deviation < 0.05.

Data analysis

Data were expressed as mean ± standard deviation; for the mathematical data processing the value of $p<0.05$ was assumed as statistically significant. One-way analysis of variance (ANOVA) was used to determine the significance of differences. In case of establishing statistically significant differences, homogeneous groups were determined by Tukey's multiple comparison test at the level of confidence $\alpha=0.05$. The statistical analyses were performed using Microsoft Excel 2007.

3. RESULTS AND DISCUSSION

Fibre increases the quality of the products and has a positive effect on the functions of human body. During the step of new food product development, it is important to determine the beneficial effects of new foods on consumer health.

Total dietary fibre content was determined in new ready to eat meals, in order to find out whether addition of functional ingredients (33% quinoa, amaranth and bulgur of total amount to potatoes 66.5%) and chicken fillet (50% replacement of control potato meal) increased dietary fibre content. The findings (Fig. 1) showed that dietary fibre content in potato meal (sample 1) was 1.80 ± 0.07 g per 100 g, while 50% replacement with chicken fillet significantly decreased dietary fibre content in the product ($p<0.05$). Cereal grains and their by-products are known to be good sources of fibre, however, several alternative pseudo cereals can be used to supplement products with fibre (Lamothe et al., 2015). Ready to eat meal (sample 2) from potatoes (66.5%) and quinoa (33%) had a significantly higher dietary fibre content (2.58 ± 0.09 g 100 g^{-1}) compared to control (sample 1) ($p<0.05$). This demonstrates that replacing one-third of potato meal with pseudo cereal quinoa, it is possible to increase total dietary fibre content.

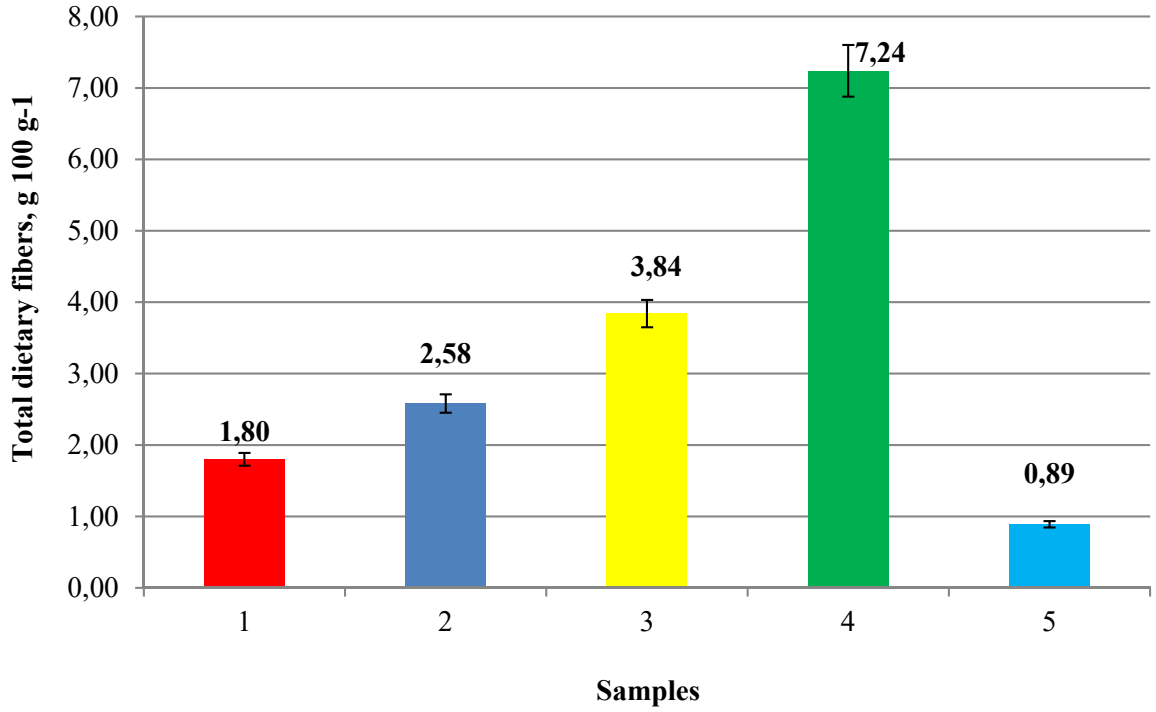


Figure 1. Total dietary fibre content (g $100g^{-1}$) in ready to eat meals.

1 – potatoes; 2 – potatoes with quinoa; 3 – potatoes with amaranth; 4 – potatoes with bulgur; 5 – potatoes with chicken fillet.

The comparison of ready to eat meals with functional ingredients showed that the most fibre rich meal was potatoes with bulgur (sample 4). Dietary fibre content in this sample was 7.24 ± 0.27 g 100 g^{-1}, which is significantly higher than in other ready to eat meal samples studied in this research, and 4 times higher than in control (sample 1). According to literature data, fibre content in bulgur is much higher than in rice (3.5 times), wheat flour (6.8 times), whole wheat bread (2.3 times) and oatmeal (1.8 times) (Erbaş et al., 2016; Yildirim et al., 2008; Bayram, Öner, 2007).

Moisture content was determined in all ready to eat meal samples after thermal treatment (Fig. 2). Moisture changes are dependent on fibre content in the product as fibre has the capacity to bind water and form gel. The highest moisture content was found in thermally processed potatoes in packaging 73.80 ± 2.12% (sample 1), which was not significantly different from sample 5, potatoes with chicken fillet (70.12 ± 2.12%) ($p>0.05$). Moisture content in ready to eat meals with functional ingredients – potatoes with quinoa, amaranth and bulgur (sample 2, 3 and 4) – was significantly different compared to control (sample 1 – potatoes) ($p<0.05$), suggesting that the added ingredients tend to absorb moisture which is released from potatoes during treatment process.

Product hardness is highly affected by product moisture content. Water absorption capacity of additional ingredients determines moisture content in ready to eat meals. The higher the water absorption capacity, the greater the hardness of the product.

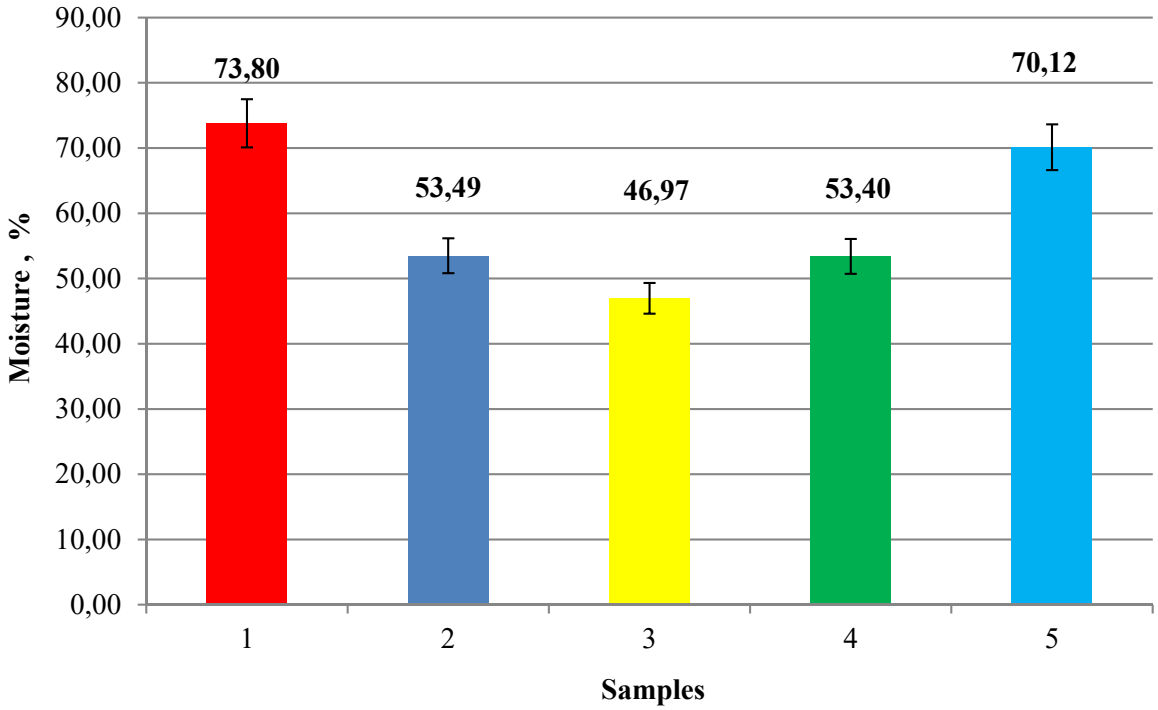


Figure 2. Moisture content (%) of ready to eat meals.

1 – potatoes; 2 – potatoes with quinoa; 3 – potatoes with amaranth; 4 – potatoes with bulgur; 5 – potatoes with chicken fillet.

In order to determine how functional ingredients and chicken fillet influenced hardness of ready to eat meals, meal samples were subjected to hardness analysis (Fig. 3).

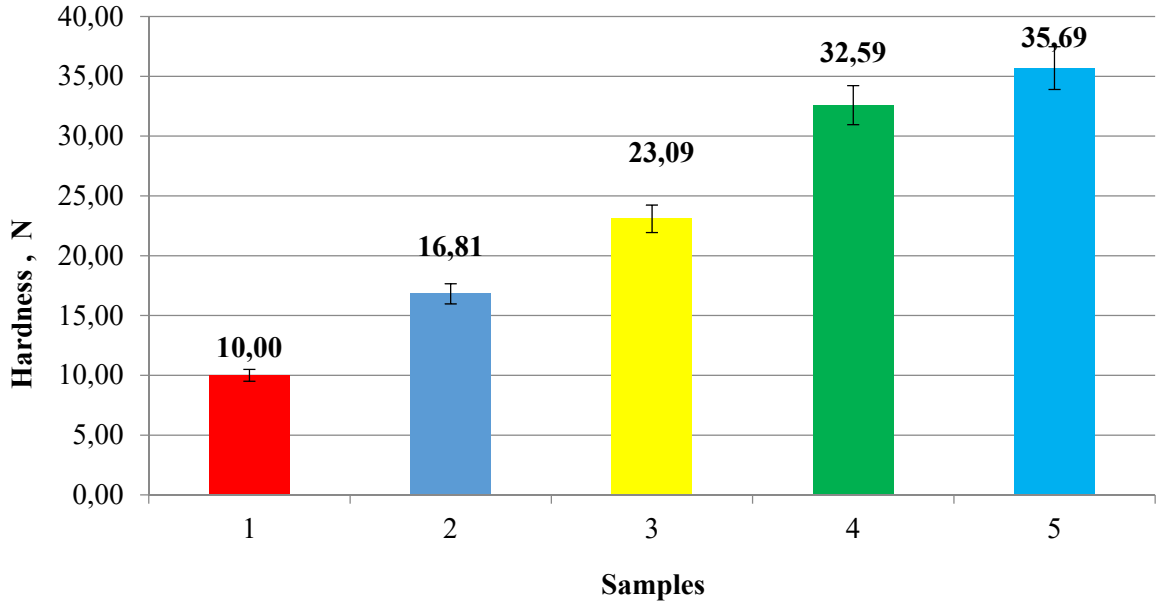


Figure 3. Hardness (N) of ready to eat meals.

1 – potatoes; 2 – potatoes with quinoa; 3 – potatoes with amaranth; 4 – potatoes with bulgur; 5 – potatoes with chicken fillet.

The results showed that potatoes (sample 1) had the lowest hardness 10.00 ± 12.35 N, and addition of pseudo cereals, bulgur and chicken fillet significantly increased hardness of ready to eat meals ($p < 0.05$). The most significant changes in hardness were observed in ready to eat potato meal with chicken fillet (sample 5); the increase in hardness was 3.5 times greater than in control (sample 1), which could be explained by the differences in the structure of the meat. By contrast, the smallest changes in hardness compared to control (sample 1) were observed in potatoes with quinoa (sample 2), where hardness increased 1.7 times. It can be concluded that addition of pseudo cereals, bulgur and chicken fillet influences the hardness of ready to eat potato meals, however, undesirable changes in quality were not found.

4. CONCLUSIONS

Changes in consumer lifestyle have influenced the increasing popularity of ready-made, ready to eat meals, which often contain potatoes with meat. Total dietary fibre in ready to eat potato meals with chicken fillet can be found in significantly small quantities (<1 g per 100 g), however, the addition of pseudo cereals – quinoa and amaranth and traditional durum wheat product – bulgur to potato meals can significantly increase ($p<0.05$) dietary fibre content in ready to eat meals up to 7.4 ± 0.23 g 100 g^{-1}.

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