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THE USE OF POLYSACCHARIDES AS DIETARY FIBERS TO IMPROVE THE FUNCTIONALITY OF FAST FOOD MEAT PRODUCTS

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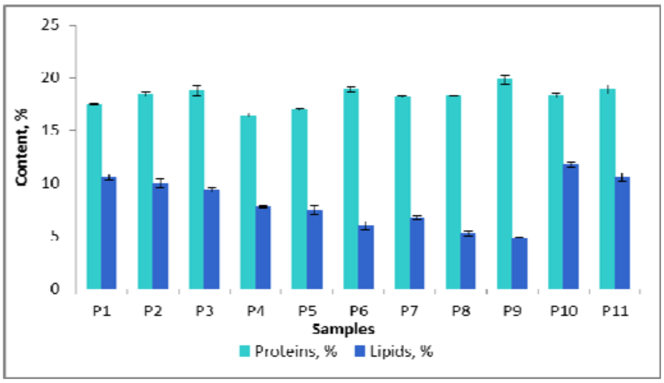
The present study aimed to assess the use of cereal bran as ingredients in order to obtain different types of fast-food and also to determine their influence on the functionality, sensory and technological properties of the finished products. Different proportions of wheat, barley husk and oats bran have been used to obtain a variety of pork meatballs. For this particular study, the physico-chemical parameters were determined, such as the moisture content, proteins content, lipids content, pH, meat hydration capacity and the freshness tests of the obtained products, such as the identification of peroxidase and H_2S. The results showed that the addition of bran leads to the increase of the content of mineral salts up to 5.76% in oat samples, 2.67% in Psyllium samples, compared to the 1.23% control sample. The highest protein content was recorded in the samples with the addition of oat bran 18.22%, 18.3% respectively 19.79%. The fat content decreased the most from 11.75% in the control sample, to 6.72- 4.82% in the wheat bran samples and to the highest lipid content was found in oat samples 10.54%-9.34%. There was an increase in the hydration capacity of the meat in the analyzed pork meatballs, from 12% in the control sample P10, up to 99% in the case of the addition of Psyllium husks, 52% for wheat bran, 33.33% for oat bran, the values being directly correlated with the amount of bran used. The lowest weight loss on frying was in wheat bran meatballs, with an average of 6.98%, than in the control samples P10 and P11, which were 22.47%, respectively 16.38%. The freshness tests have shown that bran meatballs have retained all their quality characteristics.



INTRODUCTION

Fast-food meat products are currently consumed by a growing segment of consumers due to their versatility and the short preparation time. However, the problem that arises is mainly concerned to their nutrients composition because the already consecrated and known products like burgers or patties present, nowadays, an important decrease of their essential micronutrients, mainly vitamins, minerals, but also plant dietary fibers. When it comes to manufacturing and obtaining fast food products, the marbled meat is used, a type of meat in which the adipose tissue alternates with the muscular one, to enhance certain characteristics of the products, such as succulence and tenderness, being very easy to process. For these reasons, fast-food products, besides large amounts of salt also contain saturated fats and trans fats that are formed during the applied heat treatment. To improve the functionality of a food product, several other nutrients (protein, mineral salts, dietary fiber) can

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be added while other undesirable components that may be harmful for thehuman health could be replaced. Thus, numerous studies have shown a correlation between the high fat intake and infertility, infarction, breast cancer. One of the ways in which the meat products can be functionally improved is by adding dietary fibers from plant sources.[1,2] The research conducted by Tarcea M. *et al.* (2015), showed that in Romania the national average of the Mean Dietary Fiber Intake (MDFI) is 9.8 g fiber/day/person, which approximately is 38% of the necessary.[3] Since 2003, the World Health Organization (WHO) recommends that an adult should have as an intake at least 25 grams of fibers per day.[4]

The fibers were grouped into two categories (soluble and insoluble), depending on their ability to behave in water. Soluble fibers upon the contact with water increase their volume, becoming a compact mass, leading to the sensation of satiety, with their action being assessed in the first part of the digestive system (stomach and small intestine). The soluble viscous fibers have a beneficial effect on cholesterol, including here Psyllium from *Plantago ovata*. Another beneficial contribution is by lowering the risk of cardiometabolic diseases that are the number-one cause of death in the world, nowadays. They include cardiovascular diseases, diabetes mellitus and chronic renal failure. Nonetheless, in regards to their involvement in the lowering of blood pressure, further studies need to be carried out still due to the fact that the effect is uncertain.[5]

From a chemical point of view, dietary fibers contain various polysaccharides, such as Fructo-oligosaccharides (FOS), Galacto-oligosaccharides (GOS) and Xilo-oligosaccharides (XOS). Fructo-oligosaccharides are a unique type of soluble, non-digestible carbohydrates or better known as fibers that consist of three to ten units of monosaccharides bound by α-glycosidic linkages (1-2) between the fructose and glucose terminals. The degree of polymerization (DP), as the number of monosaccharides units, was used to define and classify the fructose-oligosaccharides and inulin molecules, with the fructose-oligosaccharides having a degree of polymerization of less than 10 while the inulin has a degree of polymerization between 2 – 65.[6]

Insoluble fibers present a high water absorption capacity, hence helping to regulate the intestinal transit that is crucial for the absorption of nutrients, leading as such to the normalization of the digestion and defecation, preventing constipation, but especially helping to prevent colon cancer.[7,8] The prebiotic potential of the kidney has received some attention lately and its associated health benefits have been studied including here the benefits upon cardiovascular diseases, as well as the prevention of colon cancer, obesity and gastrointestinal diseases. In the study of Gandomani *et al.* (2017), the effect of different levels of adding strength between 5 and 30% on the sensory and the mechanical properties in the hard wheat bread was evaluated.[8] Wheat bran has been used for a long time and it respects a certain tradition, being the main research subject of many scientific studies, so that it regulated at the standard level in regards to the quality standards of this type of product. Oat bran is widely used as a fiber supplement, but its fiber content is lower than other cereal bran. This lower fiber content may be due to the high content of fat, proteins and carbohydrates, which are very difficult to separate from the cereal bark no matter which method of separation is used. An advantage for consuming products containing oat bran is the lowering of the cholesterol due to the high content of β – glucans, which are polysaccharides that can, also, attenuate the blood sugar level, slowly releasing the insulin and maintaining an important balance of the intestinal flora.[9] Numerous studies have highlighted the beneficial effect of Psyllium on conventional and emerging lipid markers in people with and without hypercholesterolemia, reinforcing its possible therapeutic role as an effective dietary mean to reduce the risk of cardiovascular disease. The lipid-lowering effect is probably related to the ability of viscous fiber to enhance the binding mechanism of bile acids and their faecal excretion, thus increasing the rate of bile acid loss and promoting the absorption of cholesterol from the blood stream in the liver for the synthesis of de novo bile acids. Due to the multiple beneficial effects, according to several studies, Psyllium is used as a supplement in various foods intended for basic diets.[10] In terms of functionality, Psyllium contains arabinoxylans. These types of compounds from other cereal grains are fermented in the colon, but in the case of Psyllium, arabionoxylans have an unknown component that impedes the fermentative process.[11] The fact that the fibers in the Psyllium gel become unfermented in the faeces positively influences the intestinal transit, both in the diarrheal corneal diseases and in the chronic constipation.[12]

The main aim of the present work was to evaluate the effect dietary fibers from wheat bran, Psyllium husk and oats bran so as to replace animal fat from fast food raw meat products such as meatballs, in order to increase the functionality, to avoid the negative effects of the saturated lipids and to preserve the sensory characteristics of the finished products, such as texture, consistency, appearance, color, taste.

RESULTS AND DISCUSSION

This study aimed to investigate the water content, protein content, lipids content, ash content, as well as the hydration capacity (HC) of 11 meat products samples obtained by the addition of the aforementioned different assortments of bran or husk, in different proportions according to Table 1. The values of the water content of the analysed samples are shown in Figure 1. The water content ranged between 74.65 % in the sample without NaCl and 64.74 % for the sample with 9% Psyllium husk. The water content decreased as the percentage of bran increased depending also on the used assortment. The water content of the analyzed products presented different valuesdepending on the amount of bran used, as well as the assortment. The P10 control sample had the highest water content 74.65%, whereas the P11 sample displayed a 71.43% water content.

Of the additions used the lowest humidity was the samples with wheat bran P1-P3, where it was 66.47%, 65.78% and 64.76%. The highest content of water was determined for the samples in which oat bran was added, the sample with 3% bran had a water content of 71.08% whereas the sample with 9% bran had a water content of 67.07%. The quantity of the bran has influenced directly the water content of all the analysed samples. According to other studies the use of indigestible polyglucides (inulins) may improve the texture, taste and water content of many foods.[16]

After the heat treatment applied that meant frying the meatballs, for 8 minutes, the weight loss detected ranged from 22.47% to 5.52%. The largest weight loss was recorded in the case of the samples without the bran samples, P10 and P11, which were 22.47%, respectively 16.38%. The smallest values were for the wheat bran samples, with an average of 6.98% compared to the average losses in the case of the samples with Psyllium husk 9.12%, respectively whereas for the ones with oat bran, 10.99%.

The content of ash (mineral substances) in the analysed samples varied depending on the amount of bran added, as well as the used assortment (Figure 2). The maximum ash value I was recorded for one of the barley bran enriched sample (P9), whereas the minimum value was recorded for the control sample (P10). The ash content ranged between 1.23% for the control sample P10 and 5.76% for the P9 sample. The Psyllium husk enhanced meatballs presented the lowest mineral salt content, the average between 3 samples being 2.67%. The meatballs with the oat bran had the highest content of mineral salts, the average between the three samples (P7-P8) being 5.30%. The results showed that the pH values did not deviate too much from the P10 and P11 reference samples, where it registered a value of 6.14. All the pH values were characteristic for the fresh meat, this representing a quality indicator for the freshness of the meat.

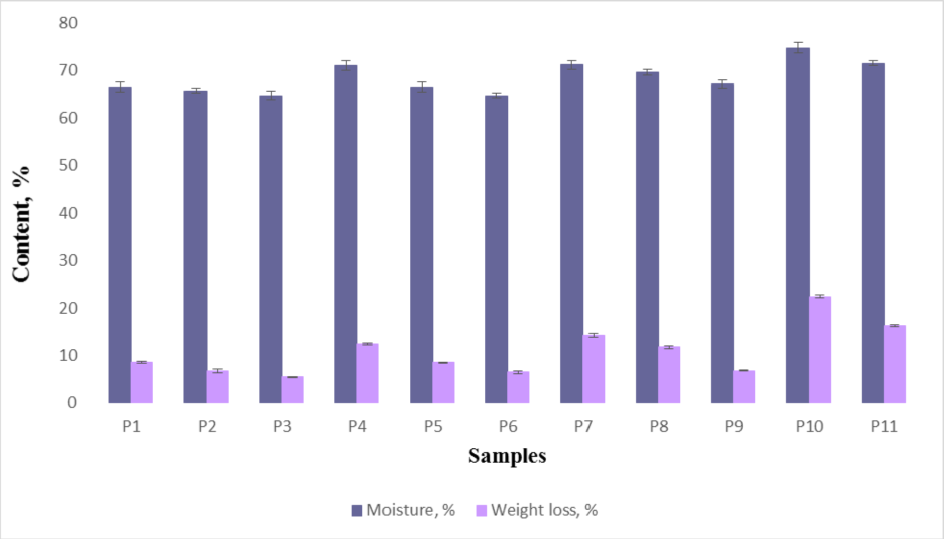

Fig. 1 – The moisture and weight loss values of obtained samples.

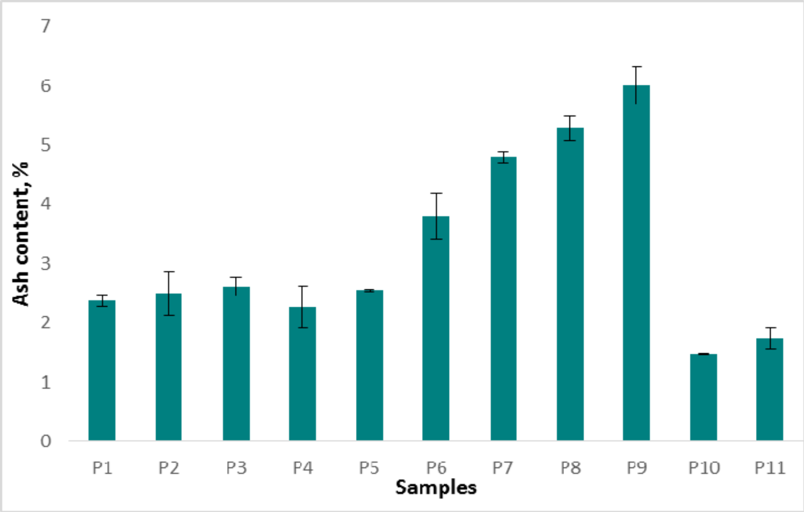

Fig. 2 – The ash content of the samples.

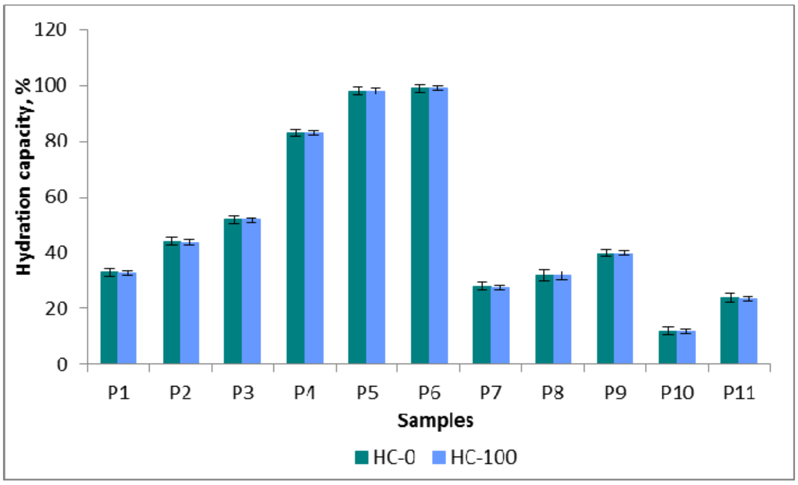

Fig. 3 – The hydration capacity of the meatballs samples at 0°C and 100°C.

The Hydration capacity it is the property of meat to absorb, but not to retain the water when it comes in contact with it. The hydration capacity values showed that at a refrigeration temperature (HC-0), the meat had a significantly higher hydration capacity, the average being 49.54%, compared to the one at 100°C (HC-100), where the average was 49.36% (Figure 3).

The small difference between HC-0 and HC-100 indicated the fact that the raw material also maintained its qualities during the thermal processing. By absorbing the water, the meat increased its volume and weight, thus improvings the tenderness and the juiciness and as a result improving also the taste and culinary qualities of the meat,through the obtainment of high quality products. This technological property is influenced as well as the ability to bind water by the same factors, such as species, age of the animal, sex, fattening status, type of muscle and the processing technologies of the fresh meat. The highest values were obtained in the case of P4, P5, P6 samples, those with the Psyllium husk addition, the P6 sample having a maximum HC-0, 99%. This hydration capacity was mentioned by Alicja Ziemichód *et al.* (2018) in the study of two species of *Psyllium plantago* and *ovata*, which absorbed 15-16 times more water than their weight, at the 20-100°C temperature.[17] Also, McRorie Jr (2019), had shown that the intact Psyllium gel, through its high water retention capacity, normalized the stool shape (hard stool softening and fluid stool adjustment) and improved the bowel function in chronic diarrhea.[12]

The lowest hydration capacity was determined for the meatballs with the addition of oat bran, with a HC-0 average of 33.33%, respectively HC-100 with 33.15%. The wheat bran increased the HC-0 from 12% for the P10 control sample, to 33%, 44% and 52%, depending on the quantity used. The tendency of increase was directly proportional to the HC and also with the amount of addition used in all the analyzed samples. The sodium chloride contributed to the growth of HC in meat, sample P11 showing a HC-0 higher than sample P10, 24%. The salt in the raw meatballs samples, such as fast food, helped to solubilize the proteins with beneficial effect on the hydration capacity of the meat and texture. The addition of salt helped solubilize the proteins by extraction the myofibrillary proteins soluble in the saline, from raw meat.[18]

The fat content of the raw material meat (P10) was 11.75% (Figure 4). By adding the aforementioned bran to all the analyzed samples, the lipid content was reduced. The most important effect was determined for wheat bran, the P1-P3 samples presented the lowest fat content, 6.72% - 4.82%, respectively. In this manner, it could be observed that the fat content decreased between 42.8% -58.97%. In the case of the oat bran in the P7-P9 samples, the proportion of lipids was the highest among all the analyzed samples, being 10.54%, 10% and 9.34%, respectively while the decrease of the lipids content was 10.29% - 29.51%. By using Psyllium husk, a fat content reduction of 39.7% was obtained on average. The lipid lowering effect, in the analysed samples was different depending on the amount of the used bran, the relationship being inversely proportional. Also, the branes had an intrinsic lipid content, which is another factor that has a high influence on the studied effect. Wheat bran had the lowest lipid content, as the manufacturer showed, 4.1%, and the highest was recorded for oat bran, 8.7% respectively. The studies conducted by Souza *et al.*, 2019 showed a decrease of the fat content in Brazilian Sausage Paio with 60.78% - 63.16%, after the addition of oat and inulin fibers.[19] Travisan *et al.*, 2016 achieved a 35% decrease of the fat content in hamburgers with added oat fiber.[20]

As shown in Figure 4, with the decrease of the fat content of the samples an improvement of their functionality was achieved, as the protein content increased directly in proportion to the amount of the bran used. The maximum protein content was observed for the P7-P9 oat samples with 18.22%, 18.3% respectively 19,79%, followed by the P1-P3 samples with the wheat bran. Meat processors are trying to find ways to reduce the fat content of the manufactured products, so that they present a smaller risk to consumers. Fat contributes to the succulence, taste and aroma of meat products, therefore the substitution or reduction of fat should not alter the essential texture and sensory properties. Beta-glucans could be such substitutes because of their ability to bind and hold water and, therefore, can give the product a good texture.[21] The tests to assess the presence of peroxidase were negative for all the samples after 48 hours of refrigeration storage of the meatballs. Peroxidase is an enzyme that belongs to the class of oxidoreductases, being present in fresh meat, being inhibited in the case of the alteration process development, as such its absence can indicate a certain stage of alteration of the meat.[22,23] Also, for all the samples, the test for the identification of H_2S showed that the compound is not found, thus, indicating the absence of sulfur proteins which meant in term the absence of the degradation phenomenon.

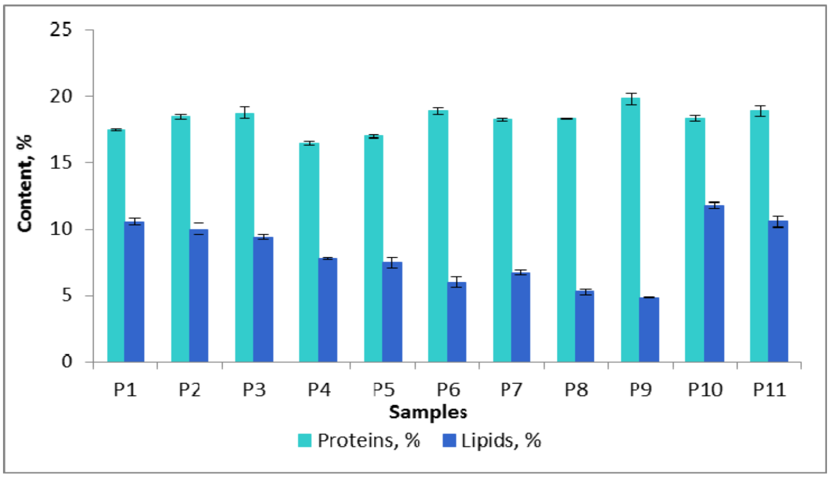

Fig. 4 – Proteins and lipids content of the obtained samples.

The sensory analysis of the samples before the heat treatment determined that the P1-P9 samples presented a firm texture, the composition showing adhesiveness, the color being darker compared to P10 and P11samples. The samples that contained Psyllium husk presented a rather gelatinous consistency and showed a high firmness after frying. After the heat treatment, the meatballs maintained their shape for the most part, except for the P9 sample, which had the highest content of oat bran and the samples without any additions. The taste was pleasant in all the analyzed cases. Other studies have also been carried out on sausages, and by analyzing their texture and sensory analysis, it has been shown that dietary fibers can be used as fat substitutes and also as a source of prebiotic ingredients.[24] Animal fat can be replaced with dietary fiber from cereals, but if certain proportions are exceeded the sensory qualities of the meat products will be affected, being no longer appreciated by consumers.[25] In another study, in order to replace some of the fat used to obtain the sausages, a larger content of beta-glucan from barley was used, so as to the fat content was reduced from 22% to 12%, whereas the addition of more than 0.8% of beta-glucan in the sausages altered the characteristics too much. The sensory acceptable content was 0,3% beta-glucan.[26]

EXPERIMENTAL

1. Materials

In the present study, to obtain the meatballs, pork chilled was used that was bought from the profile stores. The meat was minced by using an Gorenje electric machine, MG1500W, equipped with a sieve with a 3 mm slot diameter. The sources of dietary fibers were wheat bran, Psyllium husk and oats bran in the form of Sanovita commercial products that exist in the Carrefour stores. For the seasoning of the meatballs and the taste, pepper and 2 % sodium chloride were used. The raw materials and the auxiliaries were homogenized with an electric blender, afterwards being modeled into meatballs, each weighing approximately 50 g, while the diameter and the height were 6 cm, respectively 1 cm for all the samples. The codification used for the samples is presented in Table 1.

2. Methods

The water content of the samples was determined according to the SR ISO 1442:2010 by drying in an oven method, using an heat-adjustable electric oven, tipe POL-EKO-APARATURA NITECH.[13] The total ash content represented the percentage of minerals and minerals impurities from the meat products and to reach this aim, the samples were dehydrated in an oven at 125°C, afterwards being calcined at 550°C between 4-6 h. After that, the samples were added and preserved in a desiccator and weighed. The amount of ash, expressed as a percentage, was calculated as the ratio between the amount of ash resulting from calcination (g) and the amount of sample taken in the analysis (g).[14] The Supertherm STC 411.06 oven was used for calcination. One of the most used methods to determine the hydration capacity of any meat is the one developed by J.R. Bendall combined with the Sherman method.[15] The method involves weighing 10 g of minced meat, mixing it with a 10 mL of water/sodium chloride solution in a ratio 10/0.5. The quality analysis was performed for each sample immediately after their obtainment and after each heat treatment applied. After being allowed to rest for 18 hours, at 0°C, each sample was centrifuged at 3000 RPM/minute, for 20 minutes. The released liquid was decanted and measured. The remaining residue was heated for 20 minutes at 100°C, centrifuged again at 3000 RPM/minute for 20 minutes and the released liquid was measured again.

To evaluate the protein content of the pork meatballs, the total nitrogen content was determined using the Kjeldahl method.[15] The lipid content was assessed using the Soxhlet method.[15] The freshness tests performed on the analyzed products were: pH, H_2S identification, peroxidase identification. The pH was determined using the Inolab tipe pH meter, made of WTW - Germany. The H_2S identification was determined by maintaining the samples on a filter paper soaked with lead acetate solution, under given conditions. In the presence of hydrogen sulphide, the lead sulphide is formed, the color intensity being dependent on the alteration degree of the sample[22]. The peroxidase identification assay was based on its ability to break down the oxygenated water by releasing oxygen, which in term oxidizes benzidine, thus forming a blue-green colored compound that gradually passes into dark brown. The alcoholic solution of benzidine had a concentration of 0.2%. The reaction is positive, so the extract analyzed comes from of fresh meat, when after a minimum of 30 seconds and a maximum of 2 minutes the blue-green colored compound appears, which then gradually changes to dark brown. When the meat is altered the color of the extract does not change and the reaction is negative.[14, 15, 22] Sensory analysis is the scientific discipline that defines, measures, analyzes and interprets human reactions to the properties of food that can be perceived by the senses of taste, sight, smell and touch. For the sensory analysis a scoring scale of 5 points was used.[27]

Table 1

Samples codification

P1	3 % wheat bran
P2	6 % wheat bran
P3	9 % wheat bran
P4	3 % Psyllium bran
P5	6 % Psyllium bran

Table 1 (continued)

P6	9 % Psyllium bran
P7	3 % oat bran
P8	6 % oat bran
P9	9 % oat bran
P10	Pork sample without NaCl (control sample)
P11	Pork sample with 2% NaCl and without brans (control sample)

CONCLUSIONS

The water content of the products enriched with fibers in the experimental part displayed a decrease and, implicitly, the reduction of the quantitative losses during the subsequent thermal processing.

The content of mineral substances and proteins in the samples with the dietary fiber additives were quantitatively superior compared to the control sample, such as the content increased directly in proportion to the amount of fibers used, which can be considered as a method to improve the nutritional composition of the fast-food products. The polysaccharides contained in the bran and husk can be used as a substitute because of their ability to bind and even maintain it at 100^{o}C, therefore it can improve the product thus conferring a good texture, fact confirmed by the sensory evaluation. The hydration capacity of the obtained samples showed the highest values for the samples with the Psyllium husk additives and the changes followed a dose-relationship. The pH values were within the limits of freshness for the pre-packaged pork, which presented the maximum value of 6.6. The freshness tests, *i.e.* peroxidase and H_2S, performed on the samples with the addition of bran, after 48 hours of storage at the refrigeration temperature were positive and negative, respectively. Fast-food products can be excellent sources of valuable nutrients that are normally present in the meat products (proteins, iron, vitamins, etc.), but their functionality and nutritional value can be further increased and improved through the addition of food fibers, thus leading to a considerable reduction of the lipids content (over 27%) and the decrease of the energy value.

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