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Evaluation of Sensory and Physical-Chemical Properties of Smoked Sausage Based On Food Waste Sources

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Abstract

Brewer's spent grain (BSG) is a beer industry residue that represents more than 85% of the total produced by-products but at the same time it is a valuable source of of dietary fibre, protein and essential amino acids, minerals, polyphenols, vitamins and lipids. The main objective of the study is the obtaining of a traditional smoked sausage incorporating brewer's spent grain powder, establishing some correlations between storage conditions and sensory and physico-chemical characterization of the product. The substitution of meat pork with 5%, 10%, 15% brewer's spent grain powder resulted in smoked sausages formulations with enhance nutritional value. The overall acceptability scores for the control and the smoked sausages with BSG were 7.48 and 7.63–6.10 on a nine-point scale, respectively.

Keywords: brewers' spent grain, nutritional value, smoke sausage

1. Introduction

B Food waste is an ecological, economic and social problem. Every year some 1.3 billion tons of food are lost or wasted globally (FAO, 2013), representing a considerable share of the overall food produced [4].

Brewers' spent grain (BSG) is an important by-product from the brewing process, representing up to 30% (w/w) of the starting malted grain. Brewer's spent grain is a low-cost by-product of brewing, which consists of the fraction remained after the mashing and lautering process [2,9] BSG is considered to be a lignocellulosic material rich in protein and fibre, which account for around 20% and 70% of its composition, respectively [5]. The combination of large continuing supply, relatively low cost and potential nutritional value makes BSG an attractive adjunct for human food [6, 11] .

BSG has high levels of dietary fibre, protein and particularly essential amino acids, as well as appreciable levels of lipids, minerals, polyphenols and vitamins [6].

These compounds, when incorporated into human diets, may provide a number of benefits by lowering the risk of certain diseases including cancer, gastrointestinal disorders, diabetes, obesity and coronary heart disease [1]. Beside its nutritional content, one of the main advantages of using BSG in human diet is that the brewing process uses ingredients approved for human consumption. Therefore, this particular by-product can be successfully used for the development of new food products that can meet full health regulatory approval.

Meat and meat products continue to supply nutrients and play a vital role in human life because of their high biological value protein, iron, zinc, selenium and vitamin B12 contents, being a crucial component of a well balanced diet [8,9].

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The aim of the present study was to evaluate the contribution of BSG flour to the nutritional composition as well as on the sensorial properties of the enriched smoked sausage. Thus, by substituting different levels of pork meat with BSG flour (5%, 10%, 15%), three types of smoked sausages were obtained and analyzed in order to assess the overall acceptability of BSG supplemented smoked sausage compared to the 100% pork smoked sausage.

2. Materials and Methods

Brewer's spent grain was supplied by the Microbrewery of the Faculty of Food Science and Technology of UASVM Cluj-Napoca. The BSG used in this work was obtained as a by-product from a mashing process of dark lager beer with 100% all grain malted barley. The pork meat used for manufacturing the smoked pasteurized meat products were purchased from a local butchery (Cluj-Napoca, Romania).

BSG pre-treatment: Because the fresh brewer's spent grain has high moisture content it is necessary to apply a method of preservation shortly after its production.

Fresh BSG samples were preserved by oven-drying at 78 ºC for 12 hours. The samples kilned to 6% moisture content, then were grounded into powder using a laboratory milling machine, packed in sealed polyethylene bags and stored at room temperature until used.

***Smoked sausages manufacture*:** Smoked sausages were produced based on a traditional romanian recipe at the Meat Pilot Plant of the Faculty of Food Science and Technology (University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania).

The control was prepared from 75% pork sirloin and the additional ingredients were as follows by 2% salt, 0,3% black pepper, 0.4% paprika, 7% garlic, and 15.3% cold water. Three experimental smoked sausages were also prepared with different concentration of BSG samples which were incorporated into smoked sausage formulations at the levels of 5%, 10% and 15% (pork meat replacement). The batter was stuffed in 36 mm-diameter pork intestinal casings using a vacuum filling machine. Sausages were hand-linked at 20-cm intervals, then dried (at 65 °C for 30 min) and smoked (at 75 °C for 1 h) in a smoking chamber. Further they were pre-cooled at 12 °C for 30 min and cooled at 4 °C in a refrigerating chamber.

The smoked sausages thus obtained were kept under refrigeration until analysis.

Chemical composition of smoked sausage: *Determination of fat content (Soxhlet extraction methods):* Standard Soxhlet extraction method keeps the sample in contact with the solvent for a longer time. The used solvent was petroleum ether, fraction 40–60 ºC and the duration of the extractions were 6 hours. The volume of solvent was 80 ml during the extraction process. Before the solvent extraction step can begin the sample must be dried. Three mass of samples were weighed into the thimble and 1 - 1.5 g of sand were added and mixed with a glass rod. The glass rod was wiped with a piece of cotton wool and this was placed in the top of the thimble. After the thimble was inserted in a Soxhlet liquid/solid extractor a clean, dried 150 mL round bottom flash was accurately weighed and about 80 mL of solvent were introduced into the flask. The assembled extraction unit was heated over an electric heating mantle until the solvent in the flask boils. The extraction continued for 6 hours [7].

$$\% \text{ Crude fat} = (W2 - W1) \times 100 / S$$

where S = Sample weight

W2 = Weight of flask after extraction

W1 = Weight of flask prior to extraction

Determination of protein content (Kjeldahl method): The amount of protein present is then calculated from the nitrogen concentration of the food. The Kjeldahl method is divided into three steps: digestion, neutralization and titration. The food sample (1g) analyzed was weighed into a digestion flask and then digested by heating it in the presence of concentrate sulfuric acid (20 ml), copper sulphate (1g) and potassium sulfate (10g). After the digestion has been completed the digestion flask is connected to a receiving flask by a tube. The solution in the digestion flask is then made alkaline by addition of sodium hydroxide 30%. The ammonia gas that is formed is liberated from the solution and moves out of the digestion flask and into the receiving flask - which contains an excess of sulfuric acid 0.1 N and indicator phenolphthalein. The nitrogen content is then estimated by titration of sodium hydroxide 0.1 N [10].

$$P\% = V_{H2SO4} - V_{NaOH} * 0.0014 * 5.7 * 100 / ml.$$

Where V_{H2SO4} - volumes of sulphuric acid

V_{NaOH} – volume of sodium hydroxide used at titration

Determination of Moisture content:

Determination of moisture content consists in drying 5g of sample in the moisture can at 103±2 ºC until it reaches constant weight.

$$DW= G_2-G/G_1-G*100$$

$$MC= 100- DW$$

Where DW – dry weight

G_2 – mass of the sample after drying

G_1 – mass of the sample before drying

G – mass of the sample

MC – moisture content

Ash content: was determined by incineration of the sample in a muffle furnace. About 3 g of sample was weighed in a porcelain melting pot and maintained at 600 °C for 6 h in the muffle furnace. The following Equation 1 was used to calculate the ash content:

Ash content= wa/ws*100

where: wa- weight of ash, in grams;

ws- weight of sample, in grams.

Total carbohydrates: were calculated based on the following formula from the content of moisture, protein, lipid, and ash :

Total carbohydrates (g/100g) =100-(g moisture+g protein+g lipid+g ash)

Energy value: was calculated based on the following formula from the content of protein, carbohydrate, and lipid using the energy factors

Energy value (kcal/100 g) = 4*(g protein+g carbohydrate) +9* g lipid

Determination of easily hydrolysable nitrogen content (EHN) was performed based on the method described by SR 9065-7:2007 (International Organization for Standardization, 2007a) [3].

Sensory analysis - Acceptance test: Hedonic testing of the smoked sausage samples was conducted within 24 h after the sausages were prepared, in the sensory evaluation laboratory of the Faculty of Food Science and Technology, Cluj-Napoca. Sensory profiling of smoked sausage samples was performed by 30 panellists. Smoked sausage made only with pork meat was included as reference and samples were coded with random three-digit numbers and presented in a randomized order under white light. Fresh water was used to cleanse the palate between samples. The panellists evaluated all four smoked sausage formulations for aspect, colour, aroma, taste, texture and overall acceptability using a 9-point hedonic scale with 0 being “dislike extremely” and 9 being “like extremely”.

3. Results and Discussions

3.1. Compositional analysis

The moisture, protein, fat, ash, carbohydrate content as well as the energy of the two smoked sausage formulations were determined using AOAC procedures. The chemical composition of the different types of smoked sausages is shown in table 1.

Protein is the main parameter for the chemical characterization of BSG formulation products. The protein and ash contents of the BSG samples varied between 12.74-12.38% and 3.03-3.01% respectively. BSG smoked sausage formulations has also been considered as a low source of lipids due to the fact that BSG has a low lipid content and by replacing a part of the meat in the products it attracts a low lipid product.

The influence of BSG on the shelf life of the product can be seen in Table 2 where it is presented the easily hydrolysable nitrogen (EHN) content.

Easily hydrolysable nitrogen content, an indicator of freshness, also increased with storage time in smoked sausage samples. According to the Romanian legislation, Order no. 975/1998 (Romania, 1998), the easily hydrolysable nitrogen content in smoked sausages must be less than or equal to 45 mg NH_3/100g sample. Thereby, all smoked sausage samples tested have met this requirement.

Table 1. Compositional analysis of smoked sausages fortified with BSG

Sample	Moisture (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Ash (g/100 g)	Carbohydrates (g/100 g)	Energy (kcal/100 g)
SS	59,06	12,38	11,61	3,01	13,94	209,77
SS BSG 5%	58,96	12,41	11,39	3,02	14,22	209,03
SS BSG 10%	58,71	12,53	11,12	3,04	14,6	208,6
SS BSG 15%	57,58	12,74	11,04	3,03	15,61	212,76

Abbreviations: SS, smoked sausages; SSBSG5%- smoked sausages with 5% brewer's spent grain; SSBSG10%- smoked sausages with 10% brewer's spent grain; SSBSG15%- smoked sausages with 15% brewer's spent grain;

Table 2. The easily hydrolysable nitrogen (EHN) content of the products

Sample	Storage time	EHN (mg NH3/100 g)
SP	initial day	3,5
	14 days	32,17
SS BSG 5%	initial day	3,3
	14 days	35,4
SS BSG 10%	initial day	3,5
	14 days	37,5
SS BSG 15%	initial day	3,3
	14 days	38,8

Abbreviations: SS, smoked sausages; SSBSG5%- smoked sausages with 5% brewer's spent grain; SSBSG10%- smoked sausages with 10% brewer's spent grain; SSBSG15%- smoked sausages with 15% brewer's spent grain;

Table 3. Sensorial evaluation of the smoked sausage samples

Sample	*Aspect*	*Color*	*Texture*	*Taste*	*Aroma*	*Overall acceptance*
SS	7,8	7,2	7	7,4	7,6	7,4
SS BSG 5%	7,5	7,1	7,4	7,6	8	7,6
SS BSG 10%	7,2	6,4	7	6,7	6,5	6,9
SS BSG 15%	6	5,8	6	6,2	6,1	6,1

Abbreviations: SS, smoked sausages; SSBSG5%- smoked sausages with 5% brewer's spent grain; SSBSG10%- smoked sausages with 10% brewer's spent grain; SSBSG15%- smoked sausages with 15% brewer's spent grain;

3.2. Sensory analysis - Acceptance test

The smoked sausage samples were assessed by an by a panel of 30 members and the results.

A decrease in acceptability was observed when the levels of BSG were higher than 5%. The sample with 5% BSG substitution had the highest acceptability score (7.6) as well as for the other organoleptic characteristics. Also, it can be observed that the smoked sausage samples with 5% added BSG showed similar results to the control sample obtained from pork meat only.

4. Conclusion

In this study, BSG was considered as an attractive adjunct for human food because of the fact that there is a large continuous supply of the material, it is relatively cheap and is a good source of protein. The overall acceptability of the BSG enriched smoked sausage was performed by sensorial analysis, revealing good organoleptic attributes for the samples up to 5 % BSG powder.

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Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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