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THE INFLUENCE OF INULIN ADDITION ON THE PHYSICO–CHEMICAL AND SENSORY CHARACTERISTICS OF REDUCED–FAT COOKED SAUSAGES

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*In this paper, the physico–chemical and sensory characteristics of reduced–fat (approximately 35 % lower) cooked sausage, made with addition of 5% inulin, (sausage A) were examined and compared with those of conventionally cooked sausage (sausage B). Chemical composition was evaluated according to standard ISO methods. Instrumental measurements of colour (L*a*b*) and texture (Warner–Bratzler test) were performed. Sensory characteristics were estimated by a hedonic test. Protein content in sausages of A and B group (10.56 %: 10.59 %) did not differ significantly (P > 0.05). Energy value of sausage A (822.8 kJ/100g) was significantly lower (P < 0.001) than that of sausage B (1199.4 kJ/100g). Sausages with reduced fat content and with added inulin (A) had a significantly (P < 0.001) lower L* value, i.e. were darker (L* = 66.21: 69.74), significantly lower (P < 0.001) b* value (b* =13.39: 14.86), and significantly higher (P < 0.001) a* value (a* = 16.18: 12.08), comparing with the control sausages (B). Textural properties (tenderness) of both groups of sausages and sensory characteristics were evaluated as optimal, and the results of Warner–Bratzler test did not differ significantly (P > 0.05) (3.63 N: 3.77 N) between the two groups. The results obtained in this paper indicate that it is possible to produce cooked sausage with significanly reduced fat content, i.e. reduced energy value, enriched with inulin, of optimal physico-chemical and sensory characteristics.*

KEY WORDS: cooked sausages, inulin, physico-chemical and sensory characteristics, energy value

INTRODUCTION

Sausages are popular meat products enjoyed by millions of consumers worldwide (1). In Serbia, cooked sausages represent one–half of the total meat production. Cooked sausages are manufactured from a mixture of chopped meat (pork or beef), pork fat, ice wa-

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ter, soy proteins, starch, salt, additives and spices (2). Fat, as a food component, contributes to the flavour, texture, appearance of foods and increases the feeling of satiety during meals. From a physiological standpoint, fat is a source of vitamins and essential fatty acids and constitutes the most concentrated source of energy in the diet (37 kJg^{-1}) (1). However, fat intake is associated with increased risk of obesity, some types of cancer, high blood cholesterol and coronary heart disease. For these reasons, several health-related organizations (American Heart Association, American Cancer Society and World Health Organization) have proposed to limit total fat intake to no more than 30% of total calories (3). Several dietetic fibres have been used in meat products, not only to determine their possible beneficial effects on health but also as potential fat substitutes. Therefore, increased proportions of fibre in foods are known to reduce the risk of colon cancer, obesity and cardiovascular diseases. On the other hand, the addition of dietary fibre in cooked sausages has positive influence on the texture and sensory quality of the products (4). Results of Cáceres et al (3) have shown that the optimal contents of added dietary fibres in fat–reduced (approximately 35% lower) cooked sausages were between 2–12%, depending on the type of fiber. Inulin is a soluble dietary fibre (SDF) composed of a blend of fructose polymers extracted from plants. It is used as a fat substitute because of its contribution mouthfeel and low caloric value (1kcal/g) (5). With these beneficial effects in mind, this study was designed with the aim to determine the effect of inulin addition to the physico–chemical and sensory properties of fat reduced cooked sausages by comparing these sausages with the product prepared with the standard fat levels used in the industrial production.

EXPERIMENTAL

Two groups of sausages were produced. Control samples (sausages B, n= 5) were made from 55% pork meat, 30% pork fat, 10% ice water and 5% of a commercial mixture of spices and additives. In sausage A (n= 5), the percentage of pork fat was reduced by approximately 40% compared to the control, and formulation was the following: 55% pork meat, 18% pork fat, 17% ice water, 5% of the commercial mixture of spices and additives, and 5% powder – inulin. After homogenization the mixture was stuffed into artificial casings (Ø55) and sausages were kept in the bath until the geometric center of each chub which corresponds to the thickest part of the product reached 72°C. Both groups of sausages (500 g each) were stored at 4 °C for 15 days until analyzed. All measurements were performed on five sausages from each batch. Moisture, fat, protein (Kjeldahl N × 6.25) and ash contents of samples were determined according to the methods described by AOAC (6). Carbohydrates were calculated by the difference (7). Total calories (kJ) were calculated in relation to 100g of samples using the values corresponding to fat (37 kJg^{-1}), protein (17 kJg^{-1}) and carbohydrates (17 kJg^{-1}) (8). Samples for colour measurements were taken from the central part of sausages. The CIE L*a*b* (L*– lightness; a*– redness; b* –yellowness) colour coordinates (9) were determined using a MINOLTA Chroma Meter CR-400 (Minolta Co., Ltd., Osaka, Japan) with the D-65 lighting, a 2° standard observer angle and a 8-mm apperture in the measuring head. Tenderness was measured as the shear force (N) using Warner–Bratzler shear machine (Model SD-50

of 50 lb or 222 N capacity, John Chatillon & Sons, New York, NY, USA). Individual sensory quality characteristics with the following factors of significance (fs) were evaluated: external appearance of sausage (fs=3), appearance and composition of cut surface (fs=3), colour and colour maintenance on the cutting (fs=4), odor and taste (fs=6), texture and juiciness (fs=4). The overall sensory quality of sausages was evaluated according to the following expression: Overall sensory quality = (external appearance of sausage x 3 + appearance and composition of cut surface x 3 + colour and colour maintenance on the cutting x 4 + odor and taste x 6 + texture and juiciness x 4) / 20. Sensory evaluation of investigated sausages was performed by a panel consisting of 7 trained differently aged members. Evaluations were performed according to the point system of analytical descriptive test (10), using a scale from 0 to 5.

Statistical analysis

The results were evaluated statistically using the independent t-test and correlations by the software package STATISTICA 8.0 Analysis System (11).

RESULTS AND DISCUSSION

The chemical composition of the reduced–fat and inulin–added sausage (sausage A) and control (sausage B) are shown in Table 1.

Table 1. Chemical compositon and energy values of reduced–fat sausage with the addition of inulin compared to control

Groups of sausages	Moisture [%]	Fat [%]	Protein [%]	Ash [%]	Total carbohydrateses [%]	Energy value [kJ/100g]
A	63.74	17.06	10.56	2.72	5.92	822.75
B	57.55	26.27	10.59	2.81	2.79	1199.40
T	49.707***	67.994***	0.246^{ns}	2.652*	15.527***	79.73***
P	0.000	0.000	0.811	0.024	0.000	0.000

Different superscript letters represent significant differences among sausage samples.
Superscript letters * (P<0.05), ** (P<0.01), *** (P<0 .001) and ^{ns} (P >0.05)

Moisture content in the sausage A (63.74%) was significantly higher ($P < 0.001$) compared to control (57.55%). On the other hand, the fat content in sausage A (17.06%) was significantly ($P < 0.001$) lower compared to sausage B (26.27%). Good correlation was found between the moisture and fat contents ($r= –1$; $P < 0.001$) (Table 3). Protein content in sausages of A and B groups (10.56 %: 10.59 %) did not differ significantly ($P > 0.05$), and the values were within the standard defined by Serbian legislation (2). The obtained values of chemical composition are typical for cooked sausages and the results are in agreement with the literature data (12). Content of total carbohydrates in sausage A was significantly ($P < 0.001$) higher than in sausage B, and it was a consequence of the inulin addition. Energy value of sausage A showed a decrease by about 30 % comparing

to sausage B, what was related to the decrease in the fat level by about 30%. Namely, the energy value in the reduced–fat sausage with 5% of added inulin was significantly lower ($P < 0.001$) compared to control. A similar result was reported in (1) for fermented sausages with added inulin.

Colour is a very interesting parameter for cooked meat products because consumers associate this type of meat products with a bright and characteristic pink colour (3). Colour values of the reduced–fat sausage with added inulin and control are shown in Table 2. Sausage (A) had significantly lower ($P < 0.001$) L* value (L* = 66.21: 69.74) and significantly higher ($P < 0.001$) a* value (a* = 16.18: 12.08) comparing with the control (sausage B). Namely, in A batch, sausages were darker and redder than control. Correlations were found between the L* value (lightness) and fat content ($r = 0.99$; $P < 0.001$) and also between the a* value (redness) and fat content ($r = –1.00$; $P < 0.001$) (Table 3.). This was expected since the increase in the fat proportion contributes to the increase in L* value and also to the decrease in a* value. Similar results for this type of meat products were reported by several authors (13-15). On the other hand, the increase of total carbohydrates content influences a decrease of the L* value and increase of the a* value (Table 3). These results were in contrast with the literature data. The addition of the dietary fibres to cooked sausages did not seem to modify this colour in any significant way since the obtained values were very similar, and the differences appeared to be independent of the amount of added fibres (16). Comparing with the sausage B, the b* value for sausage A was significantly lower ($P < 0.001$). The values of yellowness (b*) were related to the fat content and total carbohydrates content (Table 3).

Table 2. Colour parameters of reduced–fat sausage with addition inulin compared to control

Groups of sausages	L* (lightness)	a* (redness)	b* (yellowness)
A	66.21	16.18	13.39
B	69.74	12.08	14.86
T	14.849 ***	47.752 ***	15.155 ***
P	0.000	0.000	0.000

Different superscript letters represent significant differences among sausage samples.
Superscript letters * ($P<0.05$), ** ($P<0.01$), *** ($P<0.001$) and ^{ns} ($P > 0.05$)

Tenderness have been employed by many authors to evaluate the texture of different low–fat sausages (1, 3, 17). This parametar may define the quality of the sausages and can contribute to the selection of the best functional ingredients (18). The measured values of tenderness of the reduced–fat sausages with added inulin and control are shown in Table 4. The numeric average value of shear force for sausage A (3.63 N) was slightly lower comparing to sausage B (3.77 N), but significant difference was not observed ($P > 0.05$).

Table 3. Correlation between chemical composition and shear force value and colour of examined sausages

	Moisture [%]	Fat [%]	Protein [%]	Ash [%]	Total carbohydrates [%]	Shear force [N]	L^*	a^*	b^*
Moisture [%]	1.00	-1.00***	-0.06 *ns*	-0.65*	0.98***	-0.12 *ns*	-0.98***	1.00***	-0.98***
Fat [%]		1.00	0.06 *ns*	0.65*	-0.99***	0.11 *ns*	0.99***	-1.00***	0.98***
Protein [%]			1.00	-0.27 *ns*	-0.17 *ns*	-0.04 *ns*	0.13 *ns*	-0.08 *ns*	0.04 *ns*
Ash [%]				1.00	-0.64*	-0.19 *ns*	0.57 *	-0.64*	0.63*
Total carbohydrates [%]					1.00	-0.08 *ns*	-0.98***	0.99***	-0.96***
Shear force [N]						1.00	0.08 *ns*	-0.08 *ns*	0.10 *ns*
L^*							1.00	-0.99***	0.97***
a^*								1.00	-0.98***
b^*									1.00

Different superscript letters represent significant differences among sausage samples.
Superscript letters * (P<0.05), ** (P<0.01), *** (P<0.001) and ^{ns} (P > 0.05)

Shear the force values for both groups of sausages were not significantly different because the protein contents for both groups of sausages were very similar and low (A= 10.56 %; B=10.59 %). Protein content appears to play a major role in the tenderness of the cooked sausages and that reduced fat sausages with low protein content had very similar shear force values compared to conventional sausages with the same protein content (19). However, these results are in contrast with those for similar meat products reported by the authors who found that the lower fat content (20) or dietary fibre addition (21, 22) caused significant increase in the tenderness (shear force value).

Table 4. Shear properties of reduced fat sausages with addition of inulin compared to control

Groups of sausages	Shear force [N]
A	3.63
B	3.77
T	0.328 ^{ns}
P	0.749

Different superscript letters represent significant differences among sausage samples.
Superscript letters * (P<0.05), ** (P<0.01), *** (P<0.001) and ^{ns} (P > 0.05)

Results of the sensory evaluation are presented in Table 5. External appearance did not differ significantly (P > 0.05) between groups, while average score for the appearance and composition of cut surface in sausage A was significantly higher (P < 0.05) compared to control (sausage B). Score of colour and colour maintenance on the cutting for sausage A was significantly higher than control (P < 0.01). Also, sausage A had significantly higher (P < 0.01) score for odour and taste than control (sausage B). This seems to indicate that fat reduction and inulin addition had improved the odour and taste of the sausage. Similar results were reported in (3). However, these results contrast with those for similar meat products studied by some other authors (21, 23). The scores for sensory evaluated textural properties for sausage A were not significantly different (P > 0.05) between both groups of sausages. Inulin has a high capacity to bind water and form gels that are firm, soft and stable, so the inulin addition contributed to formation of optimal sen-

sory–evaluated textural characteristics of sausages A, even when the fat content was reduced. And finally, the overall sensory quality of reduced–fat sausage with added inulin was significantly better than of control ($P < 0.01$).

Table 5. Sensory characteristics and overall acceptability of reduced–fat sausage with addition inulin compared to control

Groups of sausages	External appearance of sausage	Appearance and composition of cut surface	Colour and colour maintenance on the cutting	Odour and taste	Texture and juiciness	Overall sensory quality
A	4.72	4.36	4.70	4.62	4.65	4.63
B	4.53	3.93	4.39	4.26	4.82	4.39
t	0.921^{ns}	2.968 *	4.279 **	3.678 **	0.952^{ns}	3.878 **
P	0.379	0.014	0.002	0.004	0.354	0.003

Different superscript letters represent significant differences among sausage samples.
Superscript letters * ($P<0.05$), ** ($P<0.01$), *** ($P<0.001$) and ^{ns} ($P>0.05$)

CONCLUSION

It is possible to manufacture cooked sausages that have 30% less energy value and are enriched with the inulin with optimal physico–chemical and sensorial quality. Therefore, it is evident that this is a new functional food product, ready to be incorporated into our diet, hypocaloric and rich in a dietary fibre, which would have a favourable impact on health.

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REFERENCES

1. Mendoza, E., García, M.L., Casas, C., Selgas, M.D.: Inulin as fat substitute in low fat, dry fermented sausages. Meat Sci. **57** (2001) 387-393.
2. Serbian Regulations, Quality requirements for meat products, Official Gazette of the SFRJ (2004) (in Serbian) pp. 1-15.
3. Cáceres, E., García, M.L., Toro, J., Selgas, M.D.: The effect of fructo-oligosaccharides on the sensory characteristics of cooked sausages. Meat Sci. **68** (2004) 87-96.
4. Mauser, F.: Tehnological Aspects of Dietary Fibre, Advanced Dietary Fibre Tehnology, edited by Blackwell Science, United Kingdom (2001) pp. 239-246.
5. Izzo, M., Franck, A.: Nutritional and health benefits of inulin and oligofructose conference.Trends in Food Sci. and Tech. **9** (1998) 255-257.

6. AOAC, Official methods for the analysis. (15th ed.), Association of Official Analytical Chemists, Arlington Washington DC (1984) pp. 1-1141.
7. FAO/WHO, Carbohydrates in human nutrition. Food and Nutrition Paper 15, FAO, Rome (1980).
8. FAO, Food energy: methods of analysis and conversion factors (2003) pp. 1-87.
9. CIE. International Commission on Illumination, Colorimetry: Official Recommendation of the International Commission on Illumination. Publication CIE No. (E-1.31) Bureau Central de la CIE, Paris, France (1976).
10. Radovanović, R., Popov-Raljic, J.: Sensory analysis of food, Faculty of Agronomy, Belgrade-Zemun Serbia, Faculty of Technology, Novi Sad, Serbia (2001). p. 331.
11. STATISTICA (Data Analysis Software System), v.8.0., StatSoft, Inc, Tulsa, OK, USA (2008). Available at: http://www.statsoft.com/ (accessed 23 June 2010).
12. Sutton, D.S., Hand, L.W. and Newkirk, K.A.: Reduced fat, high moisture beef frankfurters as affected by chopping temperature. J. Food Sci. **60** (1995) 580-582.
13. Claus, J.R., Hunt, M.C.: Low fat, high added-water bologna formulated with texture modifying ingredients. J. Food Sci. **56** (1991) 643-647.
14. Troutt, E.S., Hunt, M.C., Johnson, D.E., Claus, J.R., Kastner, C.L. Kropf, D.F.: Characteristics of low-fat ground beef containing texture-modifying ingredients. J. Food Sci. **57** (1992) 19-24.
15. Grigelmo-Miguel, N. Abadía-Serós, M.I., Martín-Belloso, O.A.: Characterisation of low-fat high- dietary fiber frankfurters. Meat Sci. **52** (1999) 247-256.
16. Hughes, F., Cofrades, S., Troy, D.: Effects of fat level, oat fiber and carrageenan on frankfurters formulated with 5%, 12% and 30% fat. Meat Sci. **45** (1997) 273-281.
17. Muguerza, E., Fista, G., Ansorena, D., Astiasaran, I., Bloukas, J.B.: Effect of fat level and partial replacement of pork backfat with olive oil on processing and quality characteristics of fermented sausages. Meat Sci. **61** (2002) 397-404.
18. Herrero, A.M., Ordóñez, J.A., de Avila, M.D.R., Herranz, B., de la Hoz, L., Cambero, M.I.: Breaking strength of dry fermented sausages and their correlation with Texture Profile Analysis (TPA) and physico-chemical characteristics. Meat Sci. **77** (2007) 331-338.
19. Bloukas, J.G., Paneras, E.D.: Substituting olive oil for pork backfat affects quality of low-fat frankfurters. J.Food Sci. **58** (1993) 705-709.
20. Cross, H.R., Berry, B.W., Wells, L.H.: Effect of fat level and source on the chemical, sensory and cooking properties of ground patties. J. Food Sci. **45** (1980) 791-793.
21. Fernández-Ginés, J.M., Fernández-López, J., Sayas-Barberá, E., Sendra, E., Pérez-Álvarez, J. A.: Lemon albedo as a new source of dietary fiber: Application to bologna sausages. Meat Sci. **67** (2004) 7-13.
22. Viuda-Martos, M., Ruiz-Navajas, Y., Fernández-López, J., Pérez-Álvarez, J.A.: Effect of orange dietary fibre, oregano essential oil and packaging conditions on shelf-life of bologna sausages. Food Control. **21** (2010) 436-443.
23. Eim, V.S., Simal, S., Rosselló, C., Femenia, A.: Effects of addition of carrot dietary fibre on the ripening process of a dry fermented sausage (sobrassada). Meat Sci. **80** (2008) 173-182.

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УТИЦАЈ ДОДАТКА ИНУЛИНА НА ФИЗИЧКО-ХЕМИЈСКЕ И СЕНЗОРНЕ КАРАКТЕРИСТИКЕ ФИНО УСИТЊЕНИХ БАРЕНИХ КОБАСИЦА СА СМАЊЕНИМ САДРЖАЈЕМ МАСТИ

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У овом раду компаративно су испитане физичко-хемијске и сензорне карактеристике фино уситњених барених кобасица произведених са додатком 5% дијететских влакана (инулина) и са смањеним (за 35%) уделом масти (кобасица А) у односу на конвенционално израђену кобасицу (кобасица Б). Основни хемијски састав одређен је стандардним ИСО методама. Боја (*L*a*b** вредности) и текстура (Wb -сила пресецања) утврђени су инструментално.

Садржај укупних протеина није се статистички значајно (П > 0,05) разликовао у испитаним кобасицама А и Б групе (10,56% : 10,59%). Енергетска вредност кобасице А (822,8 kJ/100 g) била је статистички значајно мања (П < 0,05) у односу на енергетску вредност кобасице Б (1199,4 kJ/100 g). У поређењу са конвенционалном кобасицом (Б), кобасица израђена са додатком инулина и са мањим уделом масти (А) била је статистички значајно (П < 0,05) тамнија (*L** = 66,21 : 69,74), црвенија (a* = 16,18: 12,08), док је кобасица Б имала значајно (П< 0,05) већи удео жуте боје (b* =13,39 : 14,86). Текстура обе групе кобасица је сензорно оцењена као оптимална, а добијене вредности инструменталног одређивања потребне силе смицања се нису значајно (П > 0,05) разликовале (3,63 N : 3,77 N).

Анализом добијених резултата може се закључити да се значајним смањењем садржаја масти, уз додатак прехрамбених влакана (инулина) може произвести фино уситњена барена кобасица оптималних физичко-хемијских својстава, смањене енергетске вредности.

Кључне речи: барене кобасице, инулин, физичко-хемијске и сензорне карактеристике, енергетска вредност

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