Effects of bitter orange albedo addition on the quality characteristics of naturally fermented Turkish style sausages (sucuks)

Article *in* Journal of Food Agriculture and Environment · April 2010

CITATIONS
13

READS
538

2 authors, including:

Cemalettin sarıçoban
Selcuk University
73 PUBLICATIONS **681** CITATIONS

SEE PROFILE

WFL Publisher
Science and Technology
Meri-Rastilantie 3 B, FI-00980
Helsinki, Finland
e-mail: info@world-food.net

Journal of Food, Agriculture & Environment Vol.8 (2): 82-85. 2010 *www.world-food.net*

Effects of bitter orange albedo addition on the quality characteristics of naturally fermented Turkish style sausages (sucuks)

Ebru Coksever and Cemalettin Saricoban *
*Food Engineering Department, Agriculture Faculty, Selcuk University, Konya, 42049, Turkey. *e-mail: cscoban@selcuk.edu.tr*

Received 2 February 2010, accepted 8 April 2010.

Abstract

Turkish style fermented sucuk was prepared with four concentrations (0, 1, 2.5 and 5%) of bitter orange albedo (BOA). Fermentation and ripening processes were followed by pH value, lactic acid content, thiobarbituric acid reactive substances (TBARS) value, weight losses and penetrometer value analysis. During the 21 days of ripening time, pH value and moisture content decreased, and weight loss increased. Weight loss of the control (no added albedo) sample was found the highest. Titration acidity values of sucuk samples increased as a result of lactic acid formation during ripening process. The TBARS values of all samples were lower than 1 mg of malonaldehyde/kg. BOA affected the pH, lactic acid contents, TBARS values, weight losses and penetrometer values of sucuk samples. Use of low concentrations (<5%) of BOA might be a potential dietary fiber source to enhance the quality characteristics of sucuk samples.

Key words: Orange albedo, sucuk, lactic acid, TBARS, penetrometer.

Introduction

Turkish fermented sausage, called as sucuk, is produced by either natural microflora or addition of starter culture. Sucuk is a very popular semi-dried fermented meat product in Turkey and similar products are also known in most Middle Eastern Countries and Europe [1]. Sucuk can be manufactured either traditionally or commercially. Sucuk is produced from beef and water buffalo meat, beef fat, sheep tail fat, salt, sugar, nitrite and/or nitrite/nitrate and various spices [2,3]. It is preferred by customers because of its characteristic aroma and flavor [1,4-6]. However, sucuk has a high animal fat content that can be visible in the sliced product. Initial fat content is generally around 10-20%, but the fat content of the product increases up to 30-40% after drying. It is desirable to reduce the amount of fat used in fermented sausages, as it has a high content of saturated fatty acids. However, fermented sausages are one of the most difficult meat products in respect of challenge for their fat reduction [7]. Given this high fat level, it would be of interest to manufacture fermented sausages with added dietary fiber, which could have a positive effect on consumer health.

Increased concerns about the potential health risks related with the consumption of high-fat foods have led the food industry to develop new formulations or modify traditional products to make them healthier. Recent research has focused on the use of different types of fibers (inulin, cereal and fruit fibers) as partial substitutes of pork backfat in dry-fermented sausages [8-10]. Different types of citrus fibers have been successfuly used in the processing of fresh meat products [11,12], cooked meat products [13,14], non-fermented dry-cured meat products [15,16] and model meat emulsion system[17].

The name "bitter orange" refers to a citrus tree (*Citrus aurantium* L.) and its fruit. It is a widely-known, particularly tart orange which is now grown throughout the Mediterranean region. It has a thick, dimpled skin and is prized for making marmalade, being higher in pectin than the sweet orange, and therefore giving a better set and a higher yield. Citrus fruits have a potential dietary fiber source such as albedo. Albedo is a white, spongy and cellulosic tissue [14] component of citrus fruits, and could be considered as a potential fiber source. Dietary fiber sources such as albedo are not only desirable for their nutritional properties but also for their functional and technological properties [18]. In this respect, the use of fiber has been successful in improving cooking yield, reducing formulation cost, and enhancing texture in food products [19-21].

No experimental data has been found in the literature to show the effect of bitter orange albedo on the quality characteristics of naturally fermented Turkish-type sausages. The use of bitter orange albedo in sucuk manufacturing could be regarded as a good fiber source, which might improve human health and nutrition. Therefore, the main objective of this study was to determine the effect of bitter orange albedo used at 0%, 1%, 2.5% and 5% levels on the quality characteristics of naturally fermented Turkish style sausages (sucuks).

Materials and Methods

Fresh boneless beef obtained from local meat processors (butchers) in Konya, Turkey was used in this research. The beef sample was kept at temperature around 4ºC. Fat used in this study was sheep tail fat. Artificial casings (Fibran collagen, Girona, Spain) with 38 mm diameter, and ground powder spices (Onet A.S. Konya, Turkey) were used.

Bitter orange was harvested from bitter orange (*Citrus aurantium* L.) trees in Adana, Turkey. Bitter orange albedo (BOA) was picked and collected with hand from the bitter orange samples. The BOA sample was dehydrated at room temperature for 7 days.

To obtain a product with an appropriate particle size (<400 µm), the dehydrated albedo sample was ground with a homogenizer (Waring Commercial Blendor®, USA). The albedo powder obtained was vacuum packed until analysis.

Sucuk formulation and preparation: Sucuk samples were manufactured using a "natural fermentation method" (without starter culture) according to a traditional formula: fresh boneless beef and tallow fat (sheep tail fat) were cut into small pieces manually, and then NaCl (2.00%), garlic (1.15%), red pepper (0.75%), black pepper (0.45%), allspice (0.25%), cumin (0.50%), sucrose (0.50%), sodium nitrate (0.025%) and sodium nitrite (0.015%) were added into the beef and fat cuts and thoroughly mixed. The mixture was ground through a 3-mm plate and mixed again. Four different sucuk formulations were prepared in two replicate batches, and, in each dough (10 kg), different levels of dried-ground bitter orange albedo (Control, 1%, 2.5% and 5%, according to total weight) was added. For each formulation, the combined weight was 10 kg. Sucuk samples were naturally fermented. Each sucuk mixture was placed in a separate plastic box and held at 3-4ºC for 12 h to increase the penetration of ingredients into the meat. These mixtures were separately mixed and then stuffed into artificial casings (38 mm diameter) to achieve a weight of 250 ± 10 g. The samples were fermented and ripened for 21 days under ambient conditions with 70-85% relative humidity (RH). Samples were taken from each group on 0th (initial), 1st, 3rd, 7th, 14th and 21st days of ripening and analyzed on the related day. All chemical materials used in analysis were of the analytical grade.

Proximate and physico-chemical analyses: Analysis of moisture (oven air-drying method), protein (Kjeldahl Nx6.25) and fat (ether-extractable) were determined according to standard AOAC [22] procedures. For pH determination, the sucuk sample (10 g) was homogenized with 100 mL of distilled water for 1 min using a blender (Waring Commercial Blendor® USA). Then, pH was measured using a pH meter (pH 315i/SET WTW, Germany) [23]. TBARS values were colorimetrically determined using a UV-visible spectrophotometer (Hitachi U-1800 Model, Japan) according to the 2-thiobarbituric acid method[24] and expressed as mg malonaldehyde/kg sample. Lactic acid content was determined as outlined AOAC [22] and the results obtained were expressed as %w/w lactic acid. Weight losses: two strings of sucuks from each treatment were weighted just before placing in ripening chamber. The same strings were reweighed on day initial (0), 1, 3, 7, 14 and 21st day of ripening. Weight losses were expressed as percentage of the initial weight. The firmness was measured with a penetrometer (Koehler K 19500 model, Koehler Inst.,Co., Inc., USA) as outlined [25]. A lower depth of penetration indicated a harder texture.

Statistical analysis: Each parameter was tested in triplicate samples with two replications. Conventional statistical methods were used to calculate means and standard deviations. Collected data was subjected to statistical analysis using MINITAB for Windows Release 14® [26]. Multifactor analysis of variance (ANOVA) was used to evaluate the effect of ripening time (days) and concentration (0, 1, 2.5 and 5%) on the parameters studied. When a significant (P<0.01) main effect was found, the mean values were further analyzed using Duncan's Multiple Range Test [27, 28].

Results and Discussion

Proximate composition: The beef used for the production of sucuk samples contained average of 72.6% moisture and 27.4% dry matter, consisting of 20.4% protein and 5.6% fat. Mean percentages of moisture, fat and protein of the fresh product and final product are given in Table 1. For the fresh products, differences (P<0.01) were found in moisture and fat contents between treatments. As a result of moisture loss during ripening, percent protein and fat contents of the samples inclined to increase in the final products. Control sample had higher moisture content than all the samples added with bitter orange albedo (BOA). This moisture decrement explains the proportional increment observed in fat content compared to those sucuk samples added BOA (Table 1).

Lactic acid and pH: The effects of treatment and storage time on pH value and lactic acid content of fermented Turkish style sucuks are shown in Table 2. As can be seen, both albedo treatment and ripening time had a statistically significant (P<0.01) effect on pH values and lactic acid contents. The pH values of samples containing BOA were lower than that of the control (P <0.01). During 14 days of ripening period, the pH values decreased (P<0.01) from 6.22 to 5.32, mainly due to the action of lactic acid bacteria. However, it increased (P>0.01) to 5.37 in the 21st, probably due to the development of proteolytic bacteria [1].

The pH value of sucuk samples decreased during the first days of ripening time (Table 2). The pH and lactic acid behavior during fermentation stage is expected for a fermented sausage: pH decreased due to the increase in lactic acid content, as a result of carbohydrate (dextrose and lactose) breakdown by microbial metabolism [10, 12, 29].

The pH values of BOA added sucuk samples were lower than those of control samples. These results in pH may be due to the acid pH of the added bitter orange albedo (3.86). Turkish Food Codex [30] states that high quality ripened sucuks should have pH values between 5.2 and 5.4. All of sucuks were found in this range at the end of ripening time. Similar to our results, pH values of Spanish dry-fermented sausage enriched with orange fiber were reported by Fernandez-Lopez *et al.* [10].

The highest lactic acid content was found in the sucuk sample containing 5% bitter albedo (Table 2). Lactic acid content increased (P<0.01) during ripening time for all sucuks, with differences (P<0.01), which was thought to be due to orange albedo addition. Sucuk samples with albedo were a much stronger increase in lactic acid during ripening time than this of the control sample (Table 2).

After 7 days of ripening time, an increment was found in lactic acid content of sucuks compared to begining of ripening (Table 2). This higher increase in lactic acid content during ripening time has been attributed to the fact that the microorganisms could exhaust the easily fermented sugars (lactose) [31] and also that the room condition favour the exponential growth phase of the microorganisms although the microorganisms are in a dormant phase in the ripening stage [32].

Table 1. Proximate composition of fermented Turkish-style sucuks with and without bitter orange albedo (BOA) at the begining and at the end of ripening.

The concentrations of BOA	Fresh product			Final product		
	Moisture (%)	Fat (%)	Protein (%)	Moisture (%)	Fat (%)	Protein (%)
Control, 0	51.91±0.28 [a]	28.47±0.59 [a]	15.78±0.85	19.39±1.02 [b]	41.59±0.21 [a]	34.94±0.87 [a]
BOA1	51.38±0.22 [b]	28.50±0.53 [a]	15.28±0.78	20.69±1.10 [b]	40.39±0.36 [b]	32.63±1.28 [b]
BOA2.5	49.75±0.22 [c]	27.48±1.52 [a]	15.82±1.57	20.67±0.79 [b]	38.91±0.55 [c]	32.83±0.28 [b]
BOA5	48.89±0.35 [d]	25.57±0.19 [b]	15.52±1.01	22.75±1.21 [a]	36.42±0.69 [d]	31.82±0.97 [b]
P-value	**	**	ns	**	**	**

[a-d] Means within the same column with different superscript letters are different (**P< 0.01). Means based on six values. ns: not significant. Control: (no added albedo); BOA1: 1% bitter orange albedo; BOA2.5: 2.5% bitter orange albedo; BOA5: 5% bitter orange albedo.

Table 2. The effect of bitter orange albedo (BOA) addition and ripening time on pH value, TBARS value, lactic acid content, weight losses and penetrometer value of fermented Turkish-style sucuks.

Factors	pH	Lactic acid (%)	TBARS (mg MA/kg sample)	Weight loss (%)	Penetrometer value (1/10 mm)
Treatment (A)	**	**	**	**	**
Control, 0	6.03±0.29[a]	1.18±0.34[d]	0.326±0.10 [a]	28.33±11.91[a]	118.50±57.17[a]
1%	5.73±0.41[b]	1.22 ±0.28[c]	0.257±0.06 [b]	27.85±11.55[b]	119.05±53.43[a]
2.5%	5.58±0.48[c]	1.30±0.37[b]	0.284±0.06[ab]	25.63±10.87[c]	107.67±41.16[b]
5%	5.47±0.74[d]	1.37±0.47[a]	0.319±0.10[a]	25.32±10.57[c]	103.08±40.97[b]
Ripening time (days)(B)	**	**	**	**	**
0(Initial)	6.22±0.21[a]	0.79±0.05[f]	0.287±0.13[bc]	0.0	0.0
1	6.17±0.12[a]	1.00±0.12[e]	0.281±0.10[bc]	9.18±0.54[e]	197.21±26.65[a]
3	5.92±0.64[b]	1.09±0.03[d]	0.265±0.06[c]	20.06±1.40[d]	120.40±15.99[b]
7	5.35±0.28[c]	1.39±0.08[c]	0.252±0.03[c]	29.14±1.74[c]	85.85±12.54[c]
14	5.32±0.38[c]	1.54±1.17[b]	0.314±0.07[ab]	36.16±2.06[b]	88.00±13.81[c]
21	5.37±0.37[c]	1.78±0.33[a]	0.334±0.05[a]	39.39±1.69[a]	68.92±13.41[d]

[a-f] Means within the same factor and the same column with different superscript letters are different (**P< 0.01). TBARS (thiobarbituric acid reactive substances) value expressed as mg malonaldehyde/kg. Control: (no added albedo); BOA1: 1% bitter orange albedo; BOA2.5: 2.5% bitter orange albedo; BOA5: 5% bitter orange albedo.

TBARS value: The effects of treatments and ripening time on TBARS values are also shown in Table 2. Treatment and ripening time had a significant effect (P<0.01) on TBARS values of sucuk samples. The lowest TBARS value occurred in the sucuk with the BOA1 (0.257 mg MDA/kg sample) (P<0.01), while the highest one (0.326 mg MDA/kg sample) occurred in the control sample (P<0.01). According to these results, BOA1 exhibited the highest antioxidant effect compared to other treatments. This antioxidant effect might be probably due to no the reactions of nitrite with the active biocompounds present in the albedo [33].

TBARS values of sucuks were initially 0.287 mg MDA/kg sample, and then during ripening time, significantly (P<0.01) decreased until 7 days of ripening, however, increased the TBARS values until end of ripening (P<0.01) (Table 2). It was also reported that TBA value increases during the ripening time and then changes irregularly [34]. In addition, Fernandez *et al*. [35] concluded that malonaldehyde produced by lipid oxidation is not stable for a long period of time.

Weight loss: Weight loss and penetrometer values of sucuk samples are shown in Table 2. As a result of ripening process, all samples lost weight, as expected. Increasing BOA concentration in the sucuk formulation resulted in lower weight loss (P<0.01). The ripening time had a significant (P<0.01) effect on weight loss. In the control sample, the weight loss throughout ripening time was 28.33%, however for sucuk samples containing orange albedo, it decreased with BOA concentration. Weight loss of sucuk samples increased as ripening time increased (Table 2). The results obtained were similar to those reported in other studies [36, 37].

Penetrometer value: Increasing BOA concentration decreased (P<0.01) the penetrometer values, indicating that increasing albedo concentrations resulted in a harder texture. Ripening time was also a significant factor (P<0.01) to decrease the penetrometer value, thus increasing the hardness of the sucuk samples. This increased hardness in all sucuk samples was due to the water loss from the product during ripening time (Table 2).

Conclusions

In this study, the variance analysis results revealed that the bitter orange albedo (BOA) addition and the ripening process had significant effects on the pH, lactic acid, TBARS, weight loss and penetrometer values of sucuk samples. TBARS values of all sucuk samples were within acceptable limits (<1.0). In addition, further BOA addition decrased weight loss and penetrometer values, indicating that its positive effects. In the light of the results obtained, it was concluded that the use of bitter orange albedo (BOA) in the studied concentrations could be used as an ingredient for fermented Turkish style sucuk production because it did not show any negative effect on the ripening processes with respect to the studied parameters.

Acknowledgements

Authors would like to thank the Scientific Research Projects (SU-BAP-Project Number: 09201009, Konya, Turkey) of Selcuk University Coordinating Office for financial support.

References

[1]Bozkurt, H. and Erkmen, O. 2002. Effect of starter cultures and additives on the quality of Turkish style sausage (sucuk). Meat Sci. **61**:149-156.

[2]Gökalp, H.Y. 1995. Fermente et ürünleri, Sucuk Üretim Teknolojisi Standard Geleneksel Türk Et Ürünleri Özel Sayısı. Ağustos, pp. 48-55.

[3]Aksu, M. İ. and Kaya, M. 2004. Effect of *Urtica dioica* L. On microbiological properties of sucuk, a Turkish dry-fermented sausage. Food Control **15**:591-595.

[4]Üren, A. and Babayiğit, D. 1997. Colour parameters of Turkish-type fermented sausage during fermentation and ripening. Meat Sci. **45**(4): 539-549.

[5]Kayaardı, S. and Gök, V. 2003. Effect of replacing beef fat with olive oil on quality characteristics of Turkish soudjouk (sucuk). Meat Sci. **66**: 249-257.

[6]Yıldız-Turp, G. and Serdaroğlu, M. 2008. Effect of replacing beef fat with hazelnut oil on quality characteristics of sucuk-A Turkish fermented sausage. Meat Sci. **78**:447-454.

[7]Wirth, F. 1998. Technologies for making fat-reduce meat products. What possibilities are these? Fleischwirts. **68**(9):1153-1156.

[8]García, M. L., Domínguez, R., Gálvez, M. D., Casas, C. and Selgas, M. D. 2002. Utilization of cereal and fruit fibers in low fat dry fermented sausages. Meat Sci. **60**:227-236.

[9]Mendoza, E., García, M. L., Casas, C. and Selgas, M. D. 2001. Inulin as fat substitute in low fat dry fermented sausages. Meat Sci. **57**:387-393.

[10]Fernández-López, J., Sendra, E., Sayas-Barberá, E., Navarro, C. and Pérez-Alvarez, J.A. 2008. Physico-chemical and microbiological profiles of "salchichón" (Spanish fermented sausages) enriched with orange fiber. Meat Sci. **80**:410-417.

[11]Aleson-Carbonell, L., Fernández-López, J., Pérez-Alvarez, J. A. and Kuri, V. 2005a. Characteristics of beef burger as influenced by various types of lemon albedo. Innov. Food Sci. . Emerg. Technol. **6**:247–255.

[12]Aleson-Carbonell, L., Fernández-López, J., Pérez-Alvarez, J. A. and Kuri, V. 2005b. Functional and sensory effects of fiber-rich ingredients on breakfast fresh sausages manufacture. Food Sci. Technol. Int. **11**: 89–97.

[13]Fernández-Ginés, J. M., Fernández-López, J., Sayas-Barberá, M. E., Sendra, E. and Pérez-Alvarez, J. A. 2003. Effects of storage conditions on quality characteristics of bologna sausages made with citrus fiber. J. Food Sci. **68**:710–715.

[14]Fernández-Ginés, J. M., Fernández-López, J., Sayas-Barberá, M. E., Sendra, E. and Pérez-Alvarez, J. A. 2004. Lemon albedo as a new source of dietary fiber: Application to bologna sausage. Meat Sci. **67**: 7–13.

[15]Aleson-Carbonell, L., Fernández-López, J., Sayas-Barberá, M. E., Sendra, E. and Pérez Alvarez, J. A. 2003. Utilization of lemon albedo in dry-cured sausages. J. Food Sci. **68**:1826–1830.

[16]Aleson-Carbonell, L., Fernández-López, J., Sendra, E., Sayas-Barberá, M. E. and Pérez-Alvarez, J. A. 2004. Quality characteristics of a nonfermented dry-cured sausage formulated with lemon albedo. J. Sci. Food and Agric. **84**:2077–2084.

[17]Sarıçoban, C., Özalp, B., Yılmaz, M. T., Özen, G., Karakaya, M. and Akbulut, M. 2008. Characteristics of meat emulsion systems as influenced by different levels of lemon albedo. Meat Sci. **80**:599-606.

[18]Thebaudin, J. Y., Lefebvre, A. C., Harrington, M. and Bourgeosis, C. M. 1997. Dietary fibers: Nutritional and technological interest. Trends Food Sci. and Tech. **8**:41-48.

[19]Akoh, C. C. 1998. Fat replacers. Food Technol. **52**(3):47-53.

[20]Iyengar, R. and Gross, A. 1991. Fat substitutes. In Goldberg, I. and Williams, R. (eds). Biotechnology and Food Ingredients. Van Nostrand Reinhold, New York, pp. 287-313.

[21]Jiménez-Colmenero, F. 1996. Technologies for developing low-fat meat products. Trens Food Sci. Technol. **7**:41-48.

[22]AOAC 2000. Official Methods of Analysis. 17th edn. Association of Official Analytical Chemists, Arlington, Washington DC.

[23]Ockerman, H. W. 1985. Quality Control of Post-mortem Muscle Tissue. 13th edn. The Ohio State University, Columbus, OH, USA.

[24]Tarladgis, B. G., Watts, B. M. and Younathan, M. T. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chem. Soc. **37**:44-48.

[25]Candoğan, K. and Kolsarıcı, N. 2003. The effects of carrageenan and pectin on some quality characteristics of low-fat beef frankfurters. Meat Sci. **64**:199-2003.

[26]Minitab Inc. 2003. MINITAB Statistical Software, Release 14 for Windows, State College, Pennsylvania. MINITAB® is a registered trademark of Minitab Inc.

[27]MSTAT-C. 1986. Version 4.00. Michigan State Uni., East Lansing, MI.

[28]Snedecor, G. W. and Cochran, W. G. 1989. Statistical Methods. 8th edn. Iowa State University Press, Ames, IA, pp. 56-210.

[29]Muguerza, E., Fista, G., Ansorena, D., Astiasaron, I. and Bloukas, J. G. 2002. Effect of fat level and partial replacement of pork backfat with olive oil on processing and quality caharacteristics of fermented sausages. Meat Sci. **61**:397-404.

[30]Anonymous 2000. Turkish Food Codex, Türk Gıda Kodeksi, Et Ürünleri Tebliği, Tebliğ No. 2000/4. Agriculture and Rural Affairs Minister, Ankara (in Turkish).

[31]Zert, P. 1980. Saucisson sec: Matiér premiere, ingredients et additifs. In Encyclopedie de la Charcuterie. Sousana, Paris, pp. 280–281.

[32]Banwart, G. J. 1982. Microbiología básica de los alimentos. Ediciones Bellaterra, Barcelona.

[33]Nagy, S. and Attaway, J. A. 1992. Anticarcinogenic activity of phytochemicals in citrus fruit and their juice products. Proceedings of Florida State Horticultural Society **105**:162-168.

[34]Byun, M. W., Lee, J. W., Jo, C. and Yook, H. S. 2001. Quality properties of sausage made with gamma-irradiated natural pork and lamb casing. Meat Sci. **59**:223-228.

[35]Fernández, J., Pérez-Alvárez, J. A. and Fernández-López, J. A. 1997. Thiobarbituric acid test for monitoring lipid oxidation in meat. Food Chem. **59**:345-353.

[36]Karakaya, M. and Göğüş, A.K. 1993. Sucuk üretiminde farklı karbonhidrat kaynaklarının kullanılabilme olanakları üzerinde araştırmalar. Gıda **18**:319–323 (in Turkish).

[37]Sarıçoban, C., Karakaya, M. and Caner, C. 2006. Properties of Turkish-style sucuk made with different combinations of beef and hen meat. J. Muscle Foods **17**:1-8.