Development of Goat Sausage Product

Jareeporn Churjedton[1],Doungdeuan Songrit[2] & Preecha Muneesri[3]

[1]Rajamangala University of Technology Srivijaya, Faculty of Agro-Industry, Department of Food Science and Technology, Nakhon Si Thammarat,Thailand

[2] Rajamangala University of Technology Srivijaya, Faculty of Agro-Industry, Department of Product and Development , Nakhon Si Thammarat,Thailand

[3]Rajamangala University of Technology Srivijaya, Faculty of Agro-Industry, Department of Biotechnology , Nakhon Si Thammarat,Thailand

Abstract : The objective of this study was to investigate effects of three vegetable oils: soybean oil, rice bran oil, and virgin coconut oil on quality of goat sausage, using cooking loss, cutting forces and sensory scores in terms of appearance, textural firmness, juiciness and overall acceptance, as criteria to assess products quality. 26% soybean oil was preferred as the most cost-effective choice which produced non-significant results, compared to virgin coconut oil ($P \leq 0.05$). In the next step, Sung-Yod rice bran (1, 2, 3, 4 and 5%) were added to goat sausage to investigate appropriate levels of Sung-Yod rice bran on goat sausage quality. Cooking loss and cutting forces increased when percentage of Sung-Yod rice bran increased and most consumers accepted the goat sausage product with 2% Sung-Yod rice bran addition as indicated by appearance, textural firmness, juiciness and overall acceptance scores. Moreover, goat sausages were packed in polyethylene bags, vacuumed and stored at 2-4°C for 15 days to compare effectiveness of antioxidants and microbial changes in samples with Sung-Yod rice bran and praque powder. TBA values and viable count were found to increase as storage time increased. Sung-Yod rice bran is potentially promising to compensate for praque powder in terms of color improvement, rancidity retardment to a certain level, as Sung-Yod rice bran makes up of vitamin E or tocopherol which acts as natural antioxidants.

Keywords : Soybean oil, Rice bran, Rice bran oil, Virgin coconut oil, Goat sausage

*Corresponding Author: Jareeporn2000@gmail.com,Doungduean12@gmail.com, preecha.m@rmutsv.ac.th

1. Introduction

In general, major ingredients of sausage production are meat, fat and ice. Other supporting ingredients including spices, phosphate, nitrite, salt, extender and filler are used to improve quality of sausage in term of texture, taste and color in order to meet consumer's requirement (Rujanakraikarm, 1997). Goat meat was reported as a healthier fatty acid composition compared to lamb as it has lower level of hypercholesteremic fatty acid and higher levels of unsaturated fatty acid (Lee *et al.,* 2008). Goat meat is almost universally acceptable but cultural traditions and social and economic condition influence the consumer preference. As goat meat contains a high content of red muscle associated with high contents of lipid and myoglobin, therefore, these components are susceptible to oxidation and influence eating quality and storage stability of meat. In Southeast Asia, the largest concentration of goats production and consumption is found in Muslim communities (Pralomkarn,1989). Goat meat has juiciness and low fat level. Schonfeldt *et al* (1993) found that young goat meat has better smell and taste when compared to older goat meat. Pike *et al* (1973), Smith *et al* (1978) and Griffin *et al* (1992) found that acceptance in term of taste of too young goat meat is not good as older goat meat. In addition Wong *et al* (1975) and Ha and Lindsay (1990) found that level of fatty acid is commensurate with goat's specific smell which include 4-methyloxtanoic acid and 4-ethyloxtanoic acid. Other fatty acids giving similar smell include 4-methylnanoic acid and 4-ethylheptanoic acid.

Sung-Yod rice is red rice, which is a native rice of Phatthalung province. It is a soft, good taste and high nutritious rice. As these properties are required by the consumers resulting in high price of Sung-Yod rice and its derived products. Its seed coat is whitish red to dark red which is its dominant characteristic. This color is influenced by flavonoid and anthocyanins pigment which acts as antioxidant substance. Rice bran, 10 % of rice derived from rice milling, can be used for various purposes e.g. dried powdered form for drink or addition into other food products to make more valuable and beneficial products. Optimal consumption or fortification of rice bran , rice bran oil or other healthy ingredients components quantitatively or qualitatively, is one important way to help resist degenerative diseases e.g. coronary heart disease, high blood pressure and so forth.

Melting point and other important physical properties of dietary fat play a vital role in determining dietary fat quality in sausage. Swift (1968) demonstrated that incorporation of low melting point vegetable oil would result in highly oil-like sensory characteristics and low stability of the products. Such undesirable characteristics could be solved by decreasing fat content in the formulation or incorporation of desirably dietary oil as pre-emulsified form to substitute for commonly used animal-based oil.

Therefore, the objective of the research was to investigate appropriate types of consuming vegetable oil, appropriate concentration of Sung-yod rice bran substituted for nitrite as well as sensory and microbial quality changes of goat sausage during chilled storage.

2. Material and methods

2.1 Determination of appropriate types and quantities of vegetable fat

Goat meat derived from Farida Farm located in Muang District, Krabi Province were analyzed for chemical compositions which include moisture, protein, fat and ash (A.O.A.C., 1990). Three replication experiments were conducted to investigate to obtain basic formulation of goat sausage. The experiment was designed by factorial arrangement in CRD (completely randomized design) or 3 different treatments. Basic formulation used in this experiment obtained by slightly modified the formulation as provided in detail by Jareeporn (2000) and Cosenza *et.al.* (2002). These ingredients were then used for goat sausage production which its production method was adapted from Livestock Department (1988). The adapted procedure would be mentioned briefly here. Pork was cleaned, trimmed, and cut into dice shape. Later, nitrite and salt was incorporated and kept at -10 to 0 °C for 24 hours. then meat was minced through 4 mm diameter sieve . After that, goat meat , ice and other ingredients were chopped. Obtained paste was stuffed and smoked at 70 °C for 40 min. The product was cooked at 80 °C for 15 min and chilled. The products were kept in chilled condition prior to be sampled for physical, chemical and sensory quality examination for further screening to obtained basic formulation. Types and quantities of appropriate vegetable oil for production of goat meat sausage were evaluated using soybean oil, rice bran oil and virgin coconut oil at 20%, 23% and 26%, respectively. The experiment was designed for 3^2 factorial resulting in a total of 9 treatments. These formulation were subsequently used for production of goat meat sausage. Vegetable oil was first prepared for emulsion by dispersing protein isolated from soybean in water in a ratio of 1: 3 for 1 minute until it was completely dispersed. Dispersed protein was then homogenized by gradually adding oil (until dissolves completely and later ice was added. It was continued homogenizing for about 2 minutes, adding salt and continue homogenizing for 30 minutes (Figure 1). If no use, store it at 4 °C. 9 different treatments were then analyzed for their qualities.

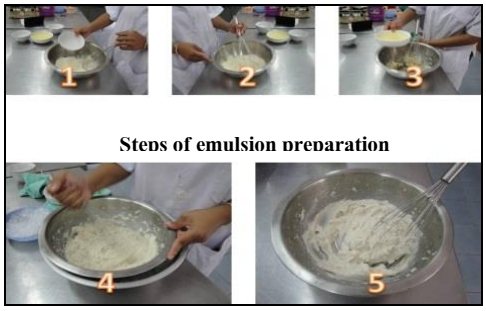

Figure.1 Step of preparing pre-emulsified emulsion

2.2 Determination of quantity of Sung-Yod rice bran to replace praque powder

Compositions of Sung-Yod rice bran were analysed and appropriate quantities of Sung-Yod rice bran were further studied to replace praque powder for goat meat sausage production. Sung-Yod rice bran was added at the level of 1%, 2%, 3%, 4% and 5%, respectively without praque powder. Sample without Sung-Yod rice bran was selected as controlled sample. The experiment was designed as CRD which all produced sausages (6 treatments with 3 replications) were subsequently analysed for their qualities.

2.3 Determination of goat meat quality changed over shelf life

Goat meat sausages were produced as followed by the mentioned procedures and were packed with polyethylene bag and sealed with vacuum machine. The products were stored at 2-4°C based on CRD experimental design. Preserved sausages with 3 replications each were analyzed for their qualities every 3 days for 15 days including TBA values, (A.O.A.C., 1990) total plate count (A.O.A.C.,1990), a_w , color and sensory test In addition, rancidity occurring in goat meat sausage products was also tested by smelling using multiple comparison tests. The panelists gave scale of perceived rancidity comparing with controlled treatment. A 5-point hedonic scale was used for giving their scale with 1 being extremely dislike and 5 being extremely like.

3. Results and Discussion

Goat meat sample consisted of moisture (75.72%), fat (0.99%), ash (0.18%) and protein (18.17%) respectively. Study of basic formulation for goat meat sausage production found that chemical composition of goat meat sausage treatment#1 had maximum moisture whilst level of fat, ash and protein had no significantly different. Value of a_w of all three treatments were not statistically different ($P \leq 0.05$).The results of cutting force test indicated that no statistical difference among three treatments of sausage reported ($P \leq 0.05$) with values ranging from 5.45 to 5.88 g /s. Color testing results (Hunter system) indicated that treatment#2 had the highest lightness (L*) and all treatments had no statistical difference ($P \leq 0.05$) since there was powder turmeric in treatment#2 which make the sausage having more lightness than other treatments. In addition, it was found that redness (a*) in treatment #1 was reported highest but no significant difference compared to all 3 treatments was found ($P \leq 0.05$). Yellowness (b*) was reported highest in sausage treatment#2 but no statistic difference was found in all treatments as well ($P \leq 0.05$). Analysis of cooking loss among three treatments of sausage indicated that percentage of cooking loss was reported at 1.72% 1.79% and 1.64% for treatment#1, 2 and 3, respectively. The sensory evaluation results of three treatments of goat meat sausage (table 1) showed that sausage treatment#1 had the highest acceptance score in term of appearance, firmness, and overall acceptability which was significantly higher than other two treatments ($P \leq 0.05$). In term of juiciness, sausage treatment#3 yielded maximal juiciness since this treatment contains sodium caseinate which better bind with water-in-oil emulsion. Based on this experiment, treatment#1 was, therefore, selected as treatment for further development of goat meat sausage.

Table 1 Sensory quality evaluation of goat sausage from scoring test

Treatment	Attribute			
	appearance	Firmness	juiciness	Overall
1	8.35[a]	8.75[a]	7.60[b]	8.35[a]
2	6.80[b]	7.10[c]	6.70[c]	7.05[c]
3	8.20[a]	7.45[b]	8.30[a]	7.45[b]

Note : [1]different letters in the same column shows statistically significant difference (P ≤ 0.05)
Formulation 1,3 (Jareeporn,2000)
Formulation 2 (Cosenza *et.al.*,2002)

3.1 Determination of types and quantities of vegetable oil (emulsion) for production

The chemical compositions indicated that the goat meat sausage produced from 26% soybean oil formulation had maximal moisture but no statistic difference was reported in goat meat sausage produced from soybean oil at 20% and 23%, rice bran oil at concentrations of 20% and 26% and coconut oil at different percentages of 20%, 23% and 26% respectively. It could be concluded that when pre-emulisified emulsion contents increased fat content in the sausage would also increase but there were no statistic differences for ash and protein. In addition, there were no significant differences for a_w of all 9 treatments of sausages. The analytical results of cutting force showed no statistic differences among these 9 treatments (P ≤ 0.05) with values ranging from 5.45 to 5.55 g/s. Colors testing results based on Hunter system showed that all 9 treatments had no statistical differences in lightness (L*), redness, (a*) and yellowness (b*) (P ≤ 0.05) respectively. Cooking loss analysis results were reported at 1.50%, 1.55%,1.64%,1.45%, 1.40%, 1.45%, 1.50%, 1.65% and 1.60% for treatment#1, 2, 3, 4, 5, 6,7, 8 and 9, respectively. The sensory evaluation of all 9 treatments of goat meat sausage based on scoring test showed treatment#9 got higher score of acceptability (in term of appearance, firmness, juiciness and overall acceptability) than other 8 treatments significantly (P ≤ 0.05). This could be explained by the fact that pre-emulsified emulsion was used instead of animal fat would assist better emulsion forming and sensory acceptance. However, no statistic difference was found when compared with treatment #3. If commercial cost was taken into account, cost of virgin coconut oil was relatively very high which was not cost-effective for commercial production. As a consequence, treatment#3 (goat sausage produced from emulsion of 26% soybean oil) was selected.

3.2 Determination Quantities of Sung-Yod rice bran to replace praque powder

Rice bran was grounded and sieved through 125 μm mesh. Based on the result (Table 2), increasing of cutting force was found when levels of rice bran were increased. This was consistent with a report by Gujral *et. al*. (2001). They reported that, shear force will increase from 37.81 to 64.13 N if isolated soy protein was added. The color testing results also indicated that the lightness

(L*) and redness (a*) (Table 2) would be decreased if rice bran quantity increased. This was because rice bran possess
naturally occurring pigment of dark brown resulting in reduced lightness. However, increasing in yellowness was found when rice bran level increased.

Table 2 Results of cutting forces, colors and a_w in goat meat sausage added rice bran at various levels

Treatment	Cutting forces (g/s)	Colors			aw
		L*	a*	b*	
Control	12.31±0.02[c]	58.30±0.00[a]	17.50±0.00[a]	33.77±0.00[f]	0.95±0.01[c]
formulation 1	13.10±0.05[c]	56.45±0.00[b]	16.62±0.00[b]	38.64±0.00[e]	0.96±0.01[c]
formulation 2	14.14±0.05[c]	51.69±0.00[c]	16.37±0.00[b]	40.39±0.00[d]	0.98±0.01[a]
formulation 3	17.10±0.10[c]	49.43±0.00[d]	13.98±0.00[c]	50.08±0.00[a]	0.97±0.01[ab]
formulation 4	19.94±0.10[b]	47.29±0.00[e]	12.47±0.00[d]	46.38±0.00[b]	0.98±0.01[a]
formulation 5	23.48±0.07[a]	46.16±0.00[f]	12.47±0.00[d]	44.36±0.00[c]	0.97±0.01[ab]

Note: [1]different letters in the same column indicate statistically significant difference ($P \leq 0.05$)
[2]average ± S.D. (three replicates)

Controls was control without Sung-Yod rice bran Formulation 1 is sample with 1% Sung-Yod rice bran Formulation 2 is sample with 2% Sung-Yod rice bran Formulation 3 is sample with 3% Sung-Yod rice bran Formulation 4 is sample with 4% Sung-Yod rice bran Formulation 5 is sample with 5% Sung-Yod rice bran

The cooking loss of 6 treatments of goat sausage was 7.84, 5.66, 5.25, 5.45, 4.76 and 7.58, respectively. Therefore, according to the sensory evaluation results of 6 treatments by scoring test, goat meat sausage added with 2% of Sung-Yod was selected (Table 3).

Table 3 Sensory scores of goat meat sausages added with Sung-Yod rice bran

treatment	Sensory attributes			
	Appearance	Firmness	Juiciness	Total acceptance
Control	5.78[c]	6.89[b]	5.89[d]	6.00[b]
formulation 1	8.00[a]	8.20[a]	8.40[a]	7.80[a]
formulation 2	8.00[a]	8.27[a]	7.70[b]	7.82[a]
formulation 3	7.90[a]	8.00[a]	8.36[a]	7.80[a]
formulation 4	6.90[b]	7.30[b]	6.80[c]	6.20[b]
formulation 5	6.10[c]	7.30[b]	6.30[d]	5.90[b]

Note: [1]different letters in the same column indicate statistically significant difference ($P \leq 0.05$) Controls was control without Sung-Yod rice bran Formulation 1 is sample with 1% Sung-Yod rice bran Formulation 2 is sample with 2% Sung-Yod rice bran Formulation 3 is sample with 3% Sung-Yod rice bran Formulation 4 is sample with 4% Sung-Yod rice bran Formulation 5 is sample with 5% Sung-Yod rice bran

3.3 Results of changes in goat meat quality over shelf life

The goat meat sausage formulation were selected and produced according to criteria provided, therefore treatment #3(with 26% soy bean oil) was packed in polyethylene bag under vacuum conditions. The goat meat product was stored at 2 to 4 °C. Based on quality analytical testing of goat sausage every 3 days for 15 days, increasing of a_w was found in first 9 days of shelf life which increased from 0.957 to 0.977 and then gradually decreased until day 15 (0.953). There were no significance changes for lightness (L*), a* and b*. But, TBA values increased througout storage time since unsaturated fatty acid might oxidize by oxygen in the ambient environment then hydroperoxide generated. The reaction occurred in product called autoxidation. Such results was consistent with a report by Rhee and Myers (2003). They reported that when the products were preserved by storing cool for 6 days, TBA values increased from 0.28-0.50 (mg malondehyde/kg sausage). Besides, Arun *et. al.,* (2008), reported the preservation of goat meat sausage added with soybean oil and frozen for 90 days, would result in slightly increasing of TBA, from 0.204 to 0.498 (mg malondehyde/kg sausage). TBA values of control sample increased from 0.251 to 0.582 (mg malondehyde/kg sausage). Total plate count increased from 1.6×10^3 CFU/mg to 4.8×10^3 CFU/mg when stored for 15 days. The sensory evaluation results in goat meat sausage preserved for 15 days indicated that rancidity increased higher than in the control sample in which no rice bran was added when compare to 2% of rice bran formulation because Sung-Yod rice bran contain vitamin E and other naturally occurring subtances which act as an antioxidative system.

4. Conclusion

It was concluded that, firstly appropriate basic formulations for goat sausage production was treatmnent#1. After that, the selected formulations were investigated by adding 3 pre-emulsified emulsion vegetative oil (soybean oil, rice bran oil and virgin coconut oil) at the level of 20, 23 and 26% respectively. It was found that formulation#3 which contained 26% soy bean oil producing the best results when scientific results and commercial cost-effective practices was also taken into account together. Afterwards, 2%Sung-Yod rice bran was selected and added to replace praque powder. Eventually, the 2% Sung-Yod rice bran formulation was kept at 2-4 °C for 15 days. TBA values and microbial count increased as shelf-life increased.

5. References

A.O.A.C. 1990.Official methods of analysis,15th ed. Association of official analytical chemist. Virginia, Arlingtion.

Arun, K.Das,Anjaneyulu, A.S.R.,Gadekar,Y.P., Singh,R.P. and Pragati,H. 2008.Effect of full-fat soy paste and textured soy granules on quality and shelf-life of goat meat nuggets in frozen storage. Meat Science.73:67-75.

Churjedton, J. 2000.Application of dietary fiber from Cocoa Husk in frankfurter sausage.Master of science in food technology prince of songkla university,songkla.144 p.

Cosenza, G.H., Williams,S.K. Johnson,D.D.,Sims,C. and McGowan,C.H. 2002. Development and evalua tion of a fermented cabrito snack stick product. Meat Science 64:51-57.

Cosenza, G.H., Williams,S.K. Johnson,D.D.,Sims,C. and McGowan,C.H. 2002. Development and evaluation of a cabrito smoked sausage product. Meat Science 64:119-124.

Griffin, C.L., Orcutt, M.W., Riley, R.R., Smith, G.C., Savell, J.W. and Shelton, M. 1992. Evaluation of the palatability of lamp, mutton and chevon by sensory panels of various cultural backgrounds.Small Rumin.Res.8:67-74.

Gujral,H.S.,Kaur,A.,Singh,N. and Sodhi,N.S. 2001.Effect of liquid whole egg , fat and textured soy protein on the textural and cooking properties of raw and baked patties from goat meat.Journal of Food Engineering 53 :377-385.

Ha, J.K. and Lindsay, R.C. 1990.Distribution of Volatile branched chain fatty acids in perinephric fats of various red meat species.Lebensmittel-Wissenschaft una-Technologie.23:433-440.

Lee,J.H.,Kannan,G.,Eega,K.R.,Kouakou,B. and Getz,W.R. 2007.Nutritional and quality characteristics of meat from goats and lambs finished under identical dietary regime. Small Rumin.Res.:55-259.

Pike, M.I., Smith, G.C. and Capenter, Z.L.1973. Palatability ratings for meat from goat and other meat animal species.J.Anim.Sci.37:269.

Pralomkarm, W. 1999. Nutritive values of meat goat.J.Songklanakarin.11:201-206.

Rhee,K.S.and Myers,C.E. 2003.Sensory properties and lipid oxidation in aerobically refrigerated cooked ground goat meat.pp.193.

Rujanakraikarm, L. 1997. Meat science and technology. Department of Food Science and Technology.Faculty of Agro-Industry Chiang Mai University.190 p.

Smith, G.C., Carpenter, Z.L. and Shelton, M. 1978.Effects of age and quality level on the palatability of goat meat.J.Amin.Sci.46:1229-1235.

Schonfeldt, H.C., Naude, R.T., Bok, W., van Heerden, S.M., Smit, R. and Boshoff, E. 1993.Flavourand tenderness related quality characteristics of goat and sheep meat.Meat Sci.34:363-379.

Wong, E., Nixon, L.N. and Johnson, C.B. 1975.Volatile medium chain fatty acids and mutton flavour.J.Agric.Food Sci.23:495-498.