IJFNPH
5,1/2/3

169

EFFECT OF ADDING CARRAGEENAN AND GELATINE ON THE QUALITY OF CHICKEN BALL

Abdul Salam Babji*, Hong Pui Khoon and Azhana Hamzah
Universiti Kebangsaan, Malaysia

Abstract: *Purpose*: The effect of kappa-carrageenan and gelatin on the quality of chicken meat ball was investigated.
Methodology: The prepared chicken meat balls underwent various tests (sensory evaluation, physical-chemical analysis, proximate analysis, microbiology, and Thiobarbituric Acid Reactive Substance Value).
Findings: Result shows that addition at lower level of carrageenan(0.3% and 0.5%) and gelatin (0.5%) increase the acceptability of the chicken balls. Physical-chemical testing shows the significant result with sensory evaluation. Addition of 0.5 % carrageenan significantly ($P<0.05$) decreases the fat content in chicken ball. No significant different for microbiology analysis with the addition of carrageenan and gelatin compared to the commersial.
Value: Carrageenan and gelatin could improve the quality of chicken meat ball by improving the physical-chemical properties and nutritional value.

Keywords: *Carrageenan; Gelatin; Quality; Chicken Meat Ball*

International Journal of Food, Nutrition & Public Health
Vol. 5 No. 1/2/3, 2012

Food Science Program, School of Chemical Sciences and Food Technology, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia
*corresponding author: Tel: +603-89215988, Fax: +603-89213232
E-mail address: daging@ukm.my

INTRODUCTION

The Asia poultry market has expanded tremendously over the years, with poultry meat rising from 20 to 25% of the total meat consumption globally. With increase in income in Asia, where GNP growth is 8-9%, poultry meat has become the natural choice, largely through its wide acceptance amongst most Asian varied communities, in comparison to beef, pork and mutton. In poultry industry, vertical integration in production and marketing chains has led to large corporations in Asia to optimize and co-ordinate activities from farm gate to the consumer (Babji et al. 2011).

Meatball is a product made of ground meat and mixed with spices (Ulu 2004) and the mixture is formed into balls and cooked (Gujral et al. 2002). According to the Food Act 1983 and Food Regulations 1985, meat balls are categorized as chicken mill, which must contain not less than 65 percent of meat and should not contain more than 30 percent fat. Processed meat products contain relatively high amounts of saturated fats and sodium, and production of healthier foods requires that these two elements by reduced. Direct reduction of fats and sodium can lead to technological difficulties, making these reductions a serious technological issue in the meat industry. (Garcia-Garcia & Totosaus 2008). Fat is important to the palatability of the products such as sausage (Kramlich 1971). Consequently, when fat is reduced in meat products they tend to become tough, dry and rubbery and do not effectively bind water (Pearson & Gillet 1999).

Thus, a gel-forming agent can be added to enhance water binding (Ruusunen & Puolanne 2005). Carrageenan was increase the hardness of meat batters when replacing fat by water-gum solution whereas carrageenan importantly improved the water holding ability (Barbut & Mittal 1992). The addition of carrageenan on the functional properties of formulated meat product has been subject of much research. Bater et al. (1992) found that carrageenan caused an increase in cooking yield, sliceability and hardness also decrease in juiciness of roasted turkey breast.

Biopolymer gelatin one of the most popular, widely used in food, pharmaceutical, cosmetic, and photographic applications due to the unique nature of work and technology. In the food industry, gelatin is used in sweets (especially to provide a chewy texture, and foam stabilizer), a low-fat butter (to provide taste creamy, reduced fat, and taste in the mouth), milk (to provide stability), baked goods (to provide an emulsion, gel formation, and stability), and meat products (to provide water binding) (Johnston-Banks, 1990; Schrieber & Gareis, 2007).

Fat oxidation is one of the major limiting factors for the quality and acceptability of meat and meat products (Ulu 2004). This process lead to drip loss, off-odour and off-flavour development and the production of potentially toxic compounds (Bekhit et al. 2003; Mc Carthy et al 2001a, 2001b; Pena-Ramos & Xiong 2003). Oxidative rancidity occurred in the presence of oxygen reacts with fat in meat and meat products. This process will shorten the life of the product acceptance (Bekhit et al. 2003).

The objective of this study is to investigate the effect of adding carrageenan and gelatin on quality of chicken balls and to produce low fat meat product.

MATERIALS AND METHOD

Chicken Balls Preparation

Chicken breast is the main ingredient in the production of chicken balls. Frozen chicken (2 kg) purchased from the

Dinding Processing Company Sdn. Bhd. Port Klang, Selangor. Meat, skin and fat was grounded, weights and kept it in the fridge. Dry ingredients such as shortening, sugar, salt, soy protein isolate, sodium tripolyphosphate, potato starch, black pepper, carrageenan and gelatin are weighed according to the specified composition before the processing carried out. The minced meat, skin, fat and shortening was put into mixer with 6% ice and mix for 1 minute. 7% of ice water used to dilute the carrageenan and gelatin. Then, dry ingredients incorporated into the mixer and mixed for 1 minute. Finally, a mixture of carrageenan and gelatin with water added and mixed for several minutes until the batter mix well. Batter was shape into balls and cooked in water temperature of 90-95°C for 5 minutes.

Sensory Evaluation

The sensory evaluation was carried out on 35-consumer panel consisting of students and staff in Universiti Kebangsaan Malaysia. Panel members are asked to determine the level of preference on each formulations using the hedonic scale of 7 points (1-dislike extremely, 7-most like) based on attributes of color, aroma, taste, juiciness, hardness and overall acceptability.

Physical-Chemical Analysis

pH value

10g of sample ground with 100 ml of distilled water for 1 minute using low speed.

Texture profile analysis

After cooked, the sample was put into the refrigerator at 4°C for 24 hours, and then samples were analyzed using the texture analyzer Shidmizu Rheometer.

Colour measurement

Color of chicken balls are determined by using Minolta CR-300 Chromameter. Color was recorded using a scale of CIE-L * a * b *. The color of the ball shown in the brightness (L *), redness (a *) and yellowness (b *) (Garcia-Garcia & Totosaus 2008). A total of three samples taken for each formulation.

Cooking yield

Chicken balls cooked in water at 90 ° C-95 ° C for 5 minutes, and then soaked in cold water for 3 minutes. The cooking yield of chicken balls determined by cooked weight over raw weight, times by 100. The cooking yield display in the form of percentage.

Proximate Analysis

Moisture, ash, protein (AOAC 1990) and fat (AOAC 1997) was determined as triplicate for each samples.

Microbiology Test

Microbiological testing of poultry products is carried through the total plate count (TPC). Computation of bacteria present in the sample is determined by using the pour plate method. Appropriate serial dilutions were plated duplicate with Plate Count Agar (Oxoid) for total mesophilic aerobic count (TMAC), and then followed by the incubation at 37 ° C for 24 hours.

Thiobarbituric Acid Reactive Substance Value

Thiobarbituric acid reactive substance (TBARS) value was determine as nmol malonaldehyde (MDA) per g sample using the procedure of Carreras et al. (2004). TBARS value was evaluated at each 0, 4, 8, 12 and 16 day refrigerated (4°C±1°C) storage period.

Statistical Analysis

Statistical analysis of data using SPSS software version 17.0. Data obtained from sensory evaluation, physical-chemical analysis, proximate analysis, microbial testing and thiobarbituric acid reactive substances were analyzed using mean comparisons, analysis of variance (ANOVA) and Duncan multiple range test to see significant differences (P <0.05) in the formulation of chicken balls. Results are displayed in tables and graphs.

RESULT AND DISCUSSION

Sensory Evaluation

There were no significant differences (P> 0.05) for the attributes color, aroma and taste. This is because the addition of carrageenan and gelatin did not change the color, aroma and taste of chicken balls. There is a significant different (P<0.05) in juiciness in chicken ball formulations with mean score range between 3.6 to 4.6. While for hardness, B3 has the highest mean score (4.7). Overall acceptance shows that, B3 and B4 place at top with mean score 4.9 and 4.7 respectively.

Physical-Chemical Analysis

Texture profile analysis

The addition of carrageenan and gelatin increase the hardness,

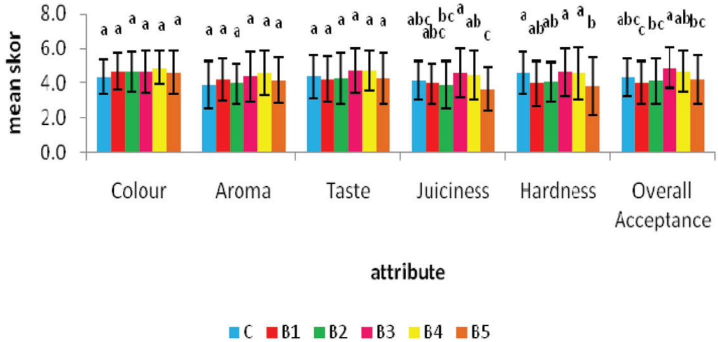

Figure 1: Show the Result on Sensory Evaluation on Chicken Balls With Addition of Carrageenan and Gelatin

gumminess and chewiness of the chicken ball. Control (C) had the lowest compared with formulations that have carrageenan and gelatin, B5 has the highest hardness, gumminess and chewiness that are 73.57 N, 39.61 N and 32.53 N.mm respectively. There is no significant different (P>0.05) in elasticity and cohesiveness in all formulation.

Color measurement

There is significantly different in L* value, B4 got the highest

Table 1: Texture Profile Analysis For All Six Formulations.

Sample	Hardness (N)	Springiness (mm)	Cohesiveness	Gumminess (N)	Chewiness (N.mm)
C	45.05 ± 1.42^{e}	0.79 ± 0.07^{a}	0.44 ± 0.08^{a}	19.75 ± 4.47^{a}	15.53 ± 2.87^{b}
B1	55.27 ± 0.30^{d}	0.86 ± 0.05^{a}	0.58 ± 0.13^{a}	32.11 ± 7.16^{ab}	27.58 ± 4.64^{a}
B2	62.92 ± 1.89^{c}	0.83 ± 0.08^{a}	0.57 ± 0.15^{a}	35.85 ± 8.94^{a}	29.29 ± 4.81^{a}
B3	54.95 ± 0.83^{d}	0.80 ± 0.03^{a}	0.39 ± 0.04^{a}	21.47 ± 2.64^{bc}	17.27 ± 2.00^{b}
B4	66.30 ± 3.04^{b}	0.78 ± 0.02^{a}	0.55 ± 0.12^{a}	36.66 ± 8.34^{a}	29.01 ± 7.41^{a}
B5	73.57 ± 1.55^{a}	0.82 ± 0.04^{a}	0.54 ± 0.06^{a}	39.61 ± 4.24^{a}	32.53 ± 5.06^{a}
p value	<0.001	0.599	0.217	0.010	0.004

value for lightness. While for redness (a*) and yellowness (b*) of the chicken balls no significant different between formulations. The redness (a*) of meat product is influenced by the hemoglobin content in the meat (Chuah & Che Rahani 1986).

pH value

B4 has the highest pH value (6.97 ± 0.01), while the lowest pH values is B1. pH value for the product is affected by the addition of added ingredients. Meat emulsions formulated with vegetable oil and rice bran fiber has a higher pH value compared with the control formulations (without any additional material added) (Choi et al. 2009). This study is similar to the observations of Moon et al. (1996) the production of low-fat sausages with the addition of oil seeds and carrageenan.

Cooking yield

There were significant differences (P <0.05) between formulations. Formulations B1, B2 and B5 after cooking to obtain percent weight of their cooking were 101.57 ± 0:41%, 103.23± 0.02 % and 103.86 ± 0.15%, which exceeded 100%. But the

Sample	L*	a*	B*	pH	Cooking yield (%)
C	70.59 ± 0.06^{b}	0.13 ± 0.45^{a}	6.98 ± 0.16^{a}	6.93 ± 0.00^{b}	99.49 ± 0.36^{d}
B1	70.31 ± 0.13^{b}	0.02 ± 0.20^{a}	6.94 ± 0.28^{a}	6.86 ± 0.01^{d}	101.57 ± 0.41^{c}
B2	70.27 ± 0.06^{b}	0.01 ± 0.17^{a}	7.16 ± 0.22^{a}	6.90 ± 0.00^{c}	103.23 ± 0.02^{b}
B3	70.59 ± 0.02^{b}	0.07 ± 0.25^{a}	6.76 ± 0.43^{a}	6.91 ± 0.01^{bc}	99.83 ± 0.06^{d}
B4	71.57 ± 0.42^{a}	0.07 ± 0.04^{a}	7.20 ± 0.37^{a}	6.97 ± 0.01^{a}	99.70 ± 0.00^{d}
B5	70.24 ± 0.26^{b}	0.19 ± 0.01^{a}	6.62 ± 0.60^{a}	6.89 ± 0.01^{c}	103.86 ± 0.15^{a}
p value	<0.001	0.340	0.412	<0.001	<0.001

Table 2:
Result of Color, pH Value and Cooking Yield for All Formulation.

formula C, B3 and B4 have suffered heavy losses after the cooked samples (approximately 100%) with a percent range of cooking yield are 99.49 % - 99.83%.

Based on the panel selection in the sensory evaluation and the results of physico-chemical analysis, there are three the best and most preferred formulation. Formulation C, B3 and B4 are selected for further analysis such as determination of nutrients (proximate), storage period with thiobarbituric acid method to determine the number of malonaldehyde and microbiological test (total plate count).

Proximate Analysis

Mean percent moisture, protein, fat and ash value of cooked chicken balls are given in Table 3. For moisture, fat and ash there are significant different (P<0.05) in mean percent. Moisture content of chicken balls ranging from 63.99% to 69.57%. Fat content are between 4.14%-13.31% were closed to the targeted level. While for ash content, the values of each formulation range between 1.74% - 1.95%. There is no significant different (P>0.05) for protein content (18.23% - 18.40%) between three formulation.

Microbiology Test

Table 3: Shows the Result on Proximate Analysis of Formulation C, B3 and B4.

Analysis	C	B3	B4	p value
Moisture	69.07 ± 0.18^{ab}	63.99 ± 3.28^{b}	69.57 ± 0.47^{a}	0.033
Ash	1.74 ± 0.05^{b}	1.95 ± 0.04^{a}	1.76 ± 0.12^{b}	0.026
Fat	12.17 ± 0.05^{b}	13.31 ± 1.06^{a}	4.14 ± 0.44^{c}	0.001
Protein	18.33±0.12	18.23±0.12	18.40±0.10	0.256
Carbohydrate	0.68 ± 0.16^{b}	2.51 ± 0.52^{b}	6.12 ± 0.89^{a}	0.014

Number of microorganisms presence in the samples was in the range of 0.75 X 10^4-1.62 X 10^4 cfu / g. Based on Food Regulations 1985, the Fifteenth Schedule (Regulation 39) of meat and meat products should contain the maximum number of microorganisms to the total plate count is below $1x10^6$ per g.

Thiobarbituric Acid Reactive Substance Value

Figure 2 shows the changes in the TBARS value. After day 0, the control had the lowest TBARS values (0.44±0.06) than B3 and B4 but there are no significant difference (P>0.05). The TBARS values increase from day 0 (0.12 nmol MDA/g chicken ball) to day 8 (0.96 nmol MDA/g chicken ball). TBARS values obtained for the three formulations increased significantly on day 8 of storage period within the range of 0.83-0.98 nmol MDA/g chicken ball. TBARS value from day 8 to day 16 decrease significantly (0.36-0.41 nmol MDA/g).

Occurrence of malonaldehyde increase on day eight in this study was similar with that reported by Ulu (2004) where on the first day of storage period the maloaldehyde value is 0.75-0.94 maloaldehyde / kg sample. But on the seventh day of storage maloaldehyde value has increased to 1.38-2.39 maloaldehyde / kg sample.

Sample	Total plate count (cfu/g)
Commercial	$0.75 \pm 0.49 \times 10^{4\ b}$
C	$1.62 \pm 0.11 \times 10^{4\ a}$
B3	$1.23 \pm 0.06 \times 10^{4\ ab}$
B4	$0.86 \pm 0.32 \times 10^{4\ ab}$
p value	0.133

Table 4:
Result of Total Plate Count for Chicken Balls

Thiobarbituric Acid Reactive Substance Value

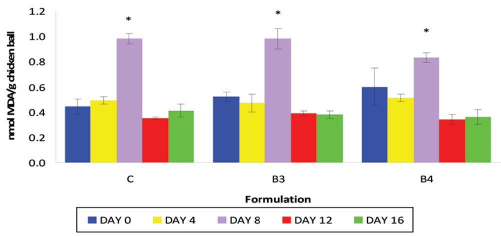

Figure 2: Malonaldehyde value of three formulation chicken balls with addition of carrageenan and gelatin.

CONCLUSION

The addition of carrageenan and gelatin improved the quality of the chicken balls based on results physico-chemical analysis, microbiological (total plate count) and thiobarbituric acid reactive substances test. Sensory analysis shows that carragenan and gelatin presence has no significance effect on chicken balls taste. However, the chicken balls texture and juiciness are markedly superior. While for the proximate analysis B4 formulation showed the best properties with total carbohydrate 6.12%, 18.40% protein, 4.14% fat, moisture and ash 69.57% and 1.76% respectively.

BIOGRAPHY

Prof. Dr. Abdul Salam Babji is currently working as a professor in National University of Malaysia; he is a senior expert with more than 30 years of experience in the field of Meat Science and Meat Technology. One of his major areas of R&D is focused on fish, meat and poultry product development with emphasis on healthy meat products. He has been actively seeking ways into replacing synthetic food additives in meat products with phytochemical-extracts of herbs and spices. These extracts are tested for their effectiveness as antioxidant and antimicrobial material, also as a tool to extend the quality and shelf life of meat products.

Ms Hong Pui Khoon (Kimi) is a Food Science graduate student in National University of Malaysia, Malaysia. Her Master degree was focused on the improvement of several Malaysia's freshwater fish protein as processed food. She is experienced in the quality assurance and product development of pasteurized fruit beverage, meat and fish products; also, in the study of gelatin extraction from animal by-products. Currently she is pursuing her doctoral degree in the University of Alberta, Canada.

Ms Azhana Hamzah is a graduate student (bachelor degree) from National University of Malaysia, Malaysia in Food Science and Nutrition course. She is experienced in product development: producing a low-fat meat product, develop pudding formulation and producing freeze dried herbs. She also experienced in polymerase chain reaction (PCR) technique for DNA detection in meat and meat products. Currently she is working as research assistant in Faculty of Science and Technology, National University of Malaysia.

ACKNOWLEDGMENT

The authors would like to thank the Ministry of Agriculture and Department of fisheries for the grant STGL-007-2010/2 and supervisor Prof. Dr. Abdul Salam Babji.

REFERRENCES

AOAC. (1990). *Official Methods of Analysis.* 15th ed. Washington D. C.:AOAC International.

AOAC. (1997). *Official Methods of Analysis.* 16th ed. Association of Official Analytical Chemists, Washington D. C.

Babji, A. S., Sahilah, A. M. & Azhana, H. (2011). New Frontier in Halal Technology. Paper presented at Halal Food Seminar (HAFOS). 7th December. Universiti Sains Islam Malaysia, Nilai, Negeri Sembilan, Malaysia.

Barbut, S. & Mittal, G. S. (1992). Use of carrageenan and xanthan gum in reduce fat breakfast sausages. *LWT-Food Science and Technologies*. 25(6): 509-513.

Bater, B., Descamps, O., and Maurer, A. J. (1992). Quality characteristics of hydrocolloid-added oven-roasted turkey breasts. *Journal of Food Science* 57 (5): 1068–1070.

Bekhit, A. E. D., Geesink, G. H., Ilian, M. A., Morton, J. D. & Bickerstaffe, R. (2003). The effect of natural antioxidants on oxidative processes and metmyoglobin reducing activity in beef patties. *Food Chemistry*. 81: 175-187.

Carreras, I., Guerrero, L., Guardia, M.D., Esteve-Garcia, E., Regueiro, J.A.G., and Sarraga, C. (2004), 'Vitamin E levels, thiobarbituric acid test and sensory evaluation of bread muscles from broilers fed α–tocopheryl acetate- and β–carotene-supplemented diets', *Journal of the Science of Food and Agriculture*, 84, 313-317.

Choi, Y. S., Jeong, J. Y., Choi, J. H. Han, D. J., Kim, H. Y. Lee, M. A., Kim, H. W. & Kim, C. J. (2009). Characteristics of low-fat meat emulsion system with pork fat replaced by vegetable oils and rice bran fiber. *Meat Science* 82: 266-271.

Chuah, E. C. & Che Rahani, Z. (1986). Faktor-faktor yang mempengaruhi mutu daging. *Teknologi Makanan* 5(1): 83-89.

Food Act and Regulations. (2010). MDC Publisher.

Garcı´a-Garcı´a, E., Totosaus, A. (2008). Low-fat sodium-reduced sausages: Effect of the interaction between locust bean gum, potato starch and j-carrageenan by a mixture design approach. *Meat science,* 78: 406–413.

Gujral, H. S., Kaur, A., Singh, N., & Sodhi, N. S. (2002). Effect of liquid whole egg, fat and textured soya protein on the textural and cooking properties of raw and baked patties from goat meat. *Journal of Food Engineering* 53: 377-385.

Johnston-Banks, F. A. (1990). Gelatin. In Harris, P. Food gels: 233–289. New York: Elsevier Applied Sciences.

Kramlich, W. E. (1971). Sausage products. In J. F. Price & B. S. Schweigert (Eds.). *The science of meat and meat products.* 2nd ed. 485-495. San Francisco: W. H. Freeman.

Mc Carthy, T. L., Kerry J. P., Kerry, J. F., Lynch, P. B. & Buckley, D. J. (2001a). Evaluation of the antioxidant potential of natural food/plant extracts as compared with synthetic antioxidants and vitamin E in raw and cooked patties. *Meat Science*. 57: 45-52.

Mc Carthy, T. L., Kerry J. P., Kerry, J. F., Lynch, P. B. & Buckley, D. J. (2001b). Assessment of the antioxidant potential of natural food and plant extracts in fresh and previously frozen pork patties. *Meat Science*. 57: 177-184.

Moon, J. D., Park, G. B., Park, B.Y., Park, T. S., Kim, J.S., Lee, J.I. (1996). Effect of seed oils, water and carrageenan on the chemical properties of low-fat sausage during cold storage. Korean Journal of Animal Science 38(4):423-433.

Pearson, A. M. & Gillet, T. A. (1999). *Processed meat*. 3rd ed. Gaithersburg: Aspen Publishers (pp: 355-371)

Pena-Ramos, E. A. & Xiong, Y. L. (2003). Whey and soya protein hydrolysates inhibit lipid oxidation in cooked pork patties. *Meat Science*. 64: 259-263.

Ruusunen, M. & Puolanne, E. (2005). Reducing sodium intake from meat products. *Meat Science*. 62: 198-202.

Schrieber, R., & Gareis, H. (2007). *Gelatine handbook*. Weinhem: Wiley-VCH GmbH & Co.

Ulu, H. (2004). Effect of wheat flour, whey protein concentrate and soya protein isolate on oxidative processes and textural properties of cooked meatballs. *Food Chemistry* 87: 523-529.