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Investigating the Effect of Adding Acacia as a Fat Substitutes on Physicochemical and Sensory Properties of Cocktail Wieners

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Abstract

The present paper examines the effect of different concentrations of acacia as a fat substitute on cocktail wiener formulations. Hence, control samples (lacking additives, containing 10% oil), Treatment 2: 5% fat, 0.5% acacia, 4.5% water; Treatment 3: 5% fat, 1% acacia, 4% water; Treatment 4: 5% fat, 1.5% acacia, 3.5% water; Treatment 5: 1.5% acacia, 8.5% water were produced and physicochemical and sensory properties of produced sausage were evaluated. Results of physicochemical tests indicated that using acacia reduces fat and cooking loss and increases humidity, carbohydrate, and ashes in the produced sausage. The best results of tissue analysis were observed in Treatment 3. Moreover, sensory analysis results showed that adding 1% and 1.5% acacia (Treatments 3 and 4, respectively) to the sausage improves its tissue, taste and, finally, leads to general acceptance of samples. Collectively, results demonstrated that using acacia (with a concentration of 1%) may be considered as a good fat substitute in low-fat sausage.

Keywords: fat substitute; acacia; tissue analysis; cocktail wieners

Introduction

High meat consumption rate is the main cause of some kinds of cancer such as gut, lung, esophagus, stomach and pancreas cancers. Furthermore, it also intensifies gout. In patients with gout, the amount of blood uric acid increases and uric acid crystalline sediments in joint cause severe pain while leading to enhanced risk of joint rheumatism. Besides, expensive price of meat leads many people, incapable of affording it, to use other meat products such as sausages and bolognas (Colmenero, 2000). According a report of Iranian Food Industries Press (2007), the per capita of sausage consumption in Iran and Europe is 1.5 and 64 Kg annually. The reason is having young population, enhance women employment and speed and facility of reaching such products. Hence, healthy production of sausage and bolognas appeals for more supervision by related authorities (Naseri, 1980; Binam, 2000).

Although oils and fats are the main sources of energy for human body and required for absorption of nutrients such as fat-diluted vitamins (D, E, K, A) and give food a desirable taste, but according to American Heart Association the fat uptake must be less than 30% of body's required energy. This is because high fat uptake causes coroner diseases, obesity, diabetes, high blood pressure and cancer. Based

on these advises and improved awareness of consumers, demand for low-fat food products enhanced significantly. Therefore, it is necessary to employ certain methods to reduce the amount of fat in products such as sausages (with 10% fat). Cocktail wieners are smaller types of hotdogs. Research shows that physicochemical and organoleptic properties of meat products are directly influenced by their fat content so that its reduction results in a considerable decrease in the quality of final product. Thus, a great deal of research is on the way on different type of fat substitutes (Tokusoglu and Kemalunal, 2003). Research indicates that increasing water content and linking it through carbohydrate-based fat substitutes is the best strategy to reduce fat content in meat products. Hydrocolloids have various capabilities such as formidability, gelation, foam stabilization, emulsification, tissue improvement, etc. At present, casein, gelatin and starch are the most widely used hydrocolloids. Deficient and expensive animal resources and prevalence of different diseases such as bovine spongiform encephalopathy (mad cow disease), changing lifestyle and tendency to herbal diets necessitate focusing on plant resources and finding new hydrocolloid resources. Acacia is a main herbal source used in fast foods because of its emulsifying, gelation, foam stabilization, consistency and tissue improvement properties (Razavi et al, 2011).

Acacia is secreted from a locust-type tree. It is easily dissolved in water and can be prepared from solutions containing up to 50% of acacia. Constructing blocks of acacia include L- arabinose, L-ramnose, D-galactose, and D-gluchronic acid. Acacia is one of the limited number of extracts requiring high concentrations for viscosity enhancement. It is also used as an emulsifier and crystallization inhibitor. Emulsification prevents fat separation or formation and growth of sugar crystals in confectionary products or ice crystals indifferent kinds of ice creams. Acacia is not consistent with some food compounds and polymers such as gelatin of sodium alginate. It is used to stabilize taste-making components in food systems. In this way, acacia surrounds the components as a new layer and prevents their formation because of volatility and drought (Lashgari et al, 2008).

The present paper aims at investigating the effect of adding different concentrations of acacia as a fat substitute on sensory and physicochemical characteristics of cocktail wieners.

Production of samples of cocktail wieners

5 kg of sheep meat bought one hour after slaughter from a slaughter house in Amol city and transferred to laboratory under standard conditions (cold chain). Then, the meat was washed with hot water and grinded using an electric grinder. In order to produce samples (control treatment) raw material weighed and mixed according to specified formulations (Table 1) to obtain a homogenous paste. The paste was then stirred and filled into the wrapper. Sausages were put into baking room with temperature of 85^{o}C for 45 min (Borghe'ei et al, 2015).

Table 1: Formulation and ingredients of sausage (control treatment)

Number	Ingredients	Percentage
1	Meat	55
2	Oil	10
3	Egg	2
4	Isolate soybean	2
5	Gluten	2
6	Dried milk	2
7	Flour	2
8	Spices	1.2
9	Salt	1.2
10	Frozen garlic	0.7
11	Sugar	0.5
12	Phosphate	0.4
13	Vitamin C	0.04

14	Nitrite	0.01
15	Ice	0.1

Moreover, different concentrations of acacia were added to the initial formulations as fat substitute. Around 5% of fat concentration decreases and remaining stages are accomplished as same as the control treatment.

Totally, 5 treatments were studied in this paper.

Treatment 1: control treatment (no additives; 10% oil)

Treatment 2: 5% fat, 0.5% acacia, 4.5% water

Treatment 3: 5% fat, 1% acacia, 4% water

Treatment 4: 5% fat, 1.5% acacia, 3.5% water

Treatment 5: 1.5% acacia, 8.5% water

Having the sausage and different treatments prepared, tissue, physicochemical and sensory tests were performed.

Chemical tests

1- Moisture measurement

Samples moisture was determined by putting them into the oven according to Iranian National Standard 2303 (Binam, 2000).

2- Protein measurement

The amount protein in homogenized samples was determined using Coldan method in accordance with Iranian National Standard 2303 (Binam, 2000).

3- Fat measurement

The amount of fat in all samples was determined using the light solvent ether 2-petrol (with boiling point of 40 – 60^{o}C) through Soxhlet method according to Iranian National Standard 2303 (Binam, 2000).

4- Ash measurement

The amount of ash in all samples was determined using an electric furnace (550^{o}C) in accordance with Iranian National Standard 2303 (Binam, 2000).

5- Cooking loss test

This test was performed based on the method proposed by Hayes et al (2011). Sausage samples were placed into a MEMMERT D91126 oven (Germany) to reach an internal temperature of 71^{o}C. They remained in this temperature for 3 min and then their cooking loss percentage was considering sausage weight before and after baking.

Cooking loss percentage = (initial weight – initial weight / total weight) ×100

Tissue test

To examine sausage tissue properties, samples bakes in 170^{o}C for 5min and then remained in 4^{o}C for 12h to decrease their central temperature to 4^{o}C. Afterwards, cubic samples (1×1×1) were cut and placed into a tissue analyzing device (with a flat probe of 40×40 mm and 10-kg load) for compaction test. The force required for sample compaction was calculated to be around 70% of their initial height under a constant velocity of 200 mm/min (Vural, 2003).

Tissue properties being studied included:

Hardness: maximum force required for sample compaction

Springiness: ability of the sample to return to its initial form after transforming force is removed.

Cohesiveness: required work to overcome cohesion forces between food surface and surface of other material in contact with the food (obtained through multiplying hardness by cohesion).

Gumminess: widening and elongating capability of the sample before tissue breaking (A1/A2).

Chewiness: required work for chewing and preparing the sample for ingestion obtained by the equation below:

Chewiness = cohesiveness ×springiness

Sensory test

To perform sensory test (color, taste, tissue, odor and general acceptance), 10 semi-trained sensory referees were asked to eat 7 samples and grade every parameter from 1 to 9 based on its desirability (Test Hedonic Scaling), where 1 represents unacceptable sample and 9 represents supreme quality. The referees used water ad pieces of bread between intervals of sample eating to remove possible remaining taste. Samples prepared by the method proposed by Lio et al (2010) in which samples are wrapped in a pieces of aluminum foil and put into the oven in order for the central temperature of sausages to reach 75^{o}C. Sausages remained in this temperature for 8min. Then, they were taken out of the oven and cut into 2cm layers having reaches the room temperature. They were rewrapped into aluminum foils and presented to referees with 3-digit codes. In order to evaluate color, tissue and appearance, referees were asked to fragment the pieces with their hand and rate the mentioned parameters based on the color of inside of sausages.

Statistical analysis

Considering normal data distribution and variance homogeneity, data was analyzed using One-Way ANOVA method. Moreover, Duncan test at the level of 5% was employed to compare data average. All data was reported in the form of average ± standard deviation and evaluations were performed in three repetitions. To analyze data and draw charts, SPSS and Excel software were used, respectively.

Objectives

1. To investigate quality improvement in low-fat sausages with different concentrations of acacia;
2. Examining the effect of different concentrations of acacia on tissue properties of low-fat sausage and comparing it with the control treatment (cocktail wiener);
3. Examining the effect of different concentrations of acacia on sensory properties of low-fat sausage and comparing it with the control treatment (cocktail wiener);
4. Investigating the effect of different concentrations of acacia on chemical compositions (fat, protein, moisture and ash) of low-fat sausage and comparing it with the control treatment (cocktail wiener).

Hypotheses

1. Adding different concentrations of acacia influences tissue properties of sausage.
2. Adding different concentrations of acacia influences sensory properties of sausage.
3. Adding different concentrations of acacia influences chemical compositions of sausage.

Findings

Table 2: Values of physicochemical parameters in different sausage treatments

	Moisture	Protein	Fat	Carbohydrate	Ash	Cooking loss
Treatment 1	55.82±0.09^{e}	13.61±0.09^{a}	18.41±0.04^{a}	5.65±0.03^{c}	2.330.007^{b}	5.13±0.021^{a}
Treatment 2	60.44±0.03^{b}	13.67±0.01a	13.53±0.01^{b}	5.8±0.08^{b}	2.37±0.007^{a}	4.93±0.035b
Treatment 3	60.07±0.04^{c}	13.68±0.01^{a}	13.53±0.01^{b}	5.91±0.01^{b}	2.38±0.014^{a}	4.43±0.014^{c}
Treatment 4	59.75±0.03^{d}	13.65±0.01^{a}	13.51±0.03^{b}	6.11±0.03^{a}	2.37±0.007^{a}	4.41±0.002^{c}
Treatment 5	64.03±0.03^{a}	13.61±0.03^{a}	8.51±0.014^{c}	6.12±0.02^{a}	2.38±0^{a}	4.83±0.015^{b}

1) All figures are resented in average ± standard deviation
2) Figures in the same column represented by different letter have significant difference (a,b,c…)

Table 3: Values of tissue properties in different sausage treatments

	Hardness (kg)	Springiness (cm)	Cohesiveness (kg)	Gumminess (g/s)	Chewiness (kg/cm)

Treatment 1	8.13 ± 0.6^{c}	0.83 ± 0.014^{ab}	5.23 ± 0.45^{c}	0.64 ± 0.007^{a}	0.41 ± 0.0042^{c}
Treatment 2	8.23 ± 0.31^{bc}	0.85 ± 0.003^{b}	5.36 ± 0.13^{b}	0.64 ± 0.007^{a}	0.43 ± 0.017^{b}
Treatment 3	9.49 ± 0.55^{a}	0.87 ± 0.006^{a}	6.07 ± 0.01^{a}	0.64 ± 0.028^{a}	0.51 ± 0.005^{a}
Treatment 4	8.31 ± 0.34^{b}	0.858 ± 0.024^{ab}	5.48 ± 0.34^{ab}	0.66 ± 0.014^{a}	0.46 ± 0.038^{b}
Treatment 5	7.29 ± 0.22^{d}	0.832 ± 0.007^{b}	5.07 ± 0.02^{d}	0.63 ± 0.028^{a}	0.38 ± 0.004^{d}

1) All figures are resented in average ± standard deviation
2) Figures in the same column represented by different letter have significant difference (a,b,c…)

Physicochemical parameters in different treatments

In this research, acacia was added to the sausage as a fat substitute. Studied treatments included: Control Treatment (no additives); Treatment 2: 5% fat, 0.5% acacia, 4.5% water; Treatment 3: 5% fat, 1% acacia, 4% water; Treatment 4: 5% fat, 1.5% acacia, 3.5% water; and Treatment 5: 1.5% acacia, 8.5% water. Results of investigating sausage properties are presented below.

In this paper, the amount of moisture was in the range between 55.82 and 64.03. The highest and the lowest amount of moisture were observed in Treatment 5 (1.5% acacia, 8.5% water) and Control Treatment, respectively. as mentioned earlier, fat concentration was decreased and water and acacia were added to the main formulation instead. Hence, moisture enhancement as a result added water seems natural. Furthermore, high water absorption capacity of acacia is another reason for moisture enhancement (Motazedi, 2004). According to Iranian National Standard 2303, maximum amount of moisture in sausages containing 51 – 60% meat is 15p + 10. This value in the present paper was estimated to be 64%. Thus it can be said that all considered treatments were in the standard moisture range.

Hashemi Ravan and Shokrane (2011) studied the effect of caboxymethyl cellulose on moisture in sausages. They reported that adding carboxymethyl cellulose has no impact on moisture rate. The reason for this difference is the use of water in acaci-containing sausages in the present paper.

Girgelmo-Miguel et al (1999) increased moisture and reduced fat in their samples by using water as a fat substitute in Frankfurter sausages.

The amount of fat in this research was estimated to be in the range between 8.5 and 18.5. The highest amount of fat (18.41%) was observed in the Control Treatment. Fat amount in acacia-containing treatments was less than control treatment because of reduced fat content used in this research. Moreover, no difference was observed between fat amount in Treatments 2, 3 and 4. The lowest fat amount was observed in Treatment 5. According to Iranian National Standard 2303, maximum amount of fat allowed in sausages containing 51 – 60% meat is 22%. Based on results, all studied treatments were in the standard range. The present research aimed to produce low-fat sausage. Other researchers tried to produce low-fat sausages.

Hosseinin et al (2011) examined the effect of different concentrations of micro-crystalline cellulose (1%, 1.25% and 1.5%) as fat substitute on fat content of hamburger. They found that microcrystalline cellulose-containing treatments contain lesser fat than the control treatment and various treatments were not significantly different. Results are consistent with those of the present paper.

Protein amount did not differ among various treatments (with an approximate value of 13.5%). In this paper, meat was used in all treatments and only fat and moisture differed among treatments. Thus, protein rate was the same in all studied treatments. According to Iranian National Standard 2303, minimum protein content in sausages containing 51% - 60% meat is 12%. All treatments of the present paper were in the standard range.

Choi et al (2010) found that using rice husk fiber significantly influences protein rate in Frankfurter sausages.

Hosseini et al (2011) reported that using microcrystalline cellulose enhances protein amount in hamburger treatments.

Carbohydrate range in this study ranged between 5.65% and 6.12%. The lowest carbohydrate amount was observed in the control treatment. Adding acacia led to an increase in carbohydrate content and enhanced concentrations of acacia increased carbohydrate content significantly. The reason is carbohydrate nature of acacia.

Ash content in this study ranged between 2.33 and 2.38. The lowest ash content was observed in the control treatment (2.33%). Adding acacia increased ash content. Moreover, ash content did not differ significantly among acacia-containing treatments. According to Iranian National Standard 2303, maximum ash content in sausages containing 51% - 60% meat in estimated to be 2.5%. Findings revealed that all treatments were in the standard range.

Hosseinin et al (2011) found that using cellulose microcrystalline enhances ash content in hamburger treatments.

Abedini et al (2009) suggested that adding melon seed as a fat substitute to bolognas increases ash content in samples.

Cooking loss in different sausage treatments

Sausage cooking efficiency depends on various factors including cooing temperature (Kim and Cheng, 2007), cooking time (Banon et al, 2008), ingredients (Hung et al, 2005) and fat content of the product (Hunges et al, 1997). In this research, adding acacia reduced cooking loss rate so that the highest cooking loss rate was observed in the control treatment (5.13%). Besides, the lowest cooking loss rate was observed in treatments 3 (5% fat, 1% acacia, 4% water) and 4 (5% fat, 1.5% acacia, 3.5% water) (4.43% and 4.41%, respectively).

Generally, gums reduce cooking los rate because of their moisture loss inhibitory effect during frying process. This originates from their ability to form hydrogen bonds with water molecules or, in other words, confining water molecules leading to prevention of moisture loss during frying process (Farajizadeh et al, 2013).

Dehdashti et al (2016) found that adding xanthan and guar gums to hamburger tissue reduces cooking loss.

Hsia et al (1992) studied the effect of hydrocolloids on chicken nuggets and found that زانتانimproves cooking efficiency.

Chung and Huss (1999) reported that using xanthan and guar gums in a type of meatball (called Kung-Wan) improves cooking efficiency as compared to the control treatment.

Choi et al (2008) suggested that adding rice bran fiber to Frankfurter sausages reduces cooking loss rate.

Choi et al (2010) stated that adding rice bran fiber (2%) and herbal oils (10%) as animal fat substitute to Frankfurter sausages enhances cooking efficiency of this product.

Demiric et al (2014) reported a higher cooking loss rate for control meatballs compared to those formulated with gums. Moreover, they found that the lowest weigh loss pertains to the treatment containing 1.5% guar gum.

Furthermore, adding water to meat products decreases cooking loss rate (Choi et al, 2015; Ahmad et al, 1990). Therefore, treatments containing acacia express lower cooking loss rates than the control treatment because of containing more water content.

Tissue analysis in different treatments

Hardness is a tissue characteristic, which is defined as the force required for transforming the product. It is also described as the force exerted by the user (through his/her teeth) to compress the product (Bourne, 2002). Adding a concentration of 1% acacia improved hardness. The highest hardness level was observed in Treatment 3 (9.49 kg). However, with a concentration of 1.5% acacia, hardness decreased. Hardness rate of treatment 4 did not differ significantly with the control treatment and the lowest hardness rate was observed in treatment 5 (7.39 kg).

It seems that adding gums up to a concentration of 1% improves linkage between meat proteins, hence, producing a harder, more integrated tissue and prevents sausage deformity (Alvarez et al, 2012).

Nevertheless, adding concentrations more than 1% reduces deteriorates links between meat proteins and finally decreases hardness rate (Mittal and Barbut, 1993). Moreover, higher water and moisture content in the formulation led to softened product.

Demiric et al (2014) examined the effect of adding different concentrations (0.5, 1 and 1.5) of xanthan and guar gums on physicochemical, sensory and tissue properties f meatballs and compared it to a control treatment. They found that adding gums hardened and improved meatball tissue.

By definition, springiness refers to the capability of the sample to return to the initial state after the transforming force is removed (Szczesniak, 2002). This characteristic is directly related to hardness of the treatment (Marchetti et al, 2013). In fact, formation of a mesh construct enhances springiness (Zhou et al, 2010). In the present research, the highest (0.87 cm) and the lowest springiness rates were observed in treatments 3 (5% fat, 1% acacia, 4% water) and 5 (1.5% acacia, 8.5% water), respectively.

In general, cohesiveness represents the strength and stability of internal bands forming the main body of the product. In physical terms, cohesiveness is the resistance of a product and its transformation limit before the main structure is broken (Andres et al, 2006). Results of cohesiveness tests were similar to those of tissue hardness. The highest (6.07 kg) and the lowest (5.07 kg) cohesiveness rates were observed in treatments 3 (5% fat, 1% acacia, 4% water) and 5 1.5% acacia, 8.5% water), respectively.

Gumminess is defined as the required work for overcoming adsorption forces between the sample and other surfaces in contact with it (Szczesniak, 2002). In the present study, gumminess rates did not differ significantly among various treatments. Results concerning gumminess are consistent with those of Dehdashti et al (2016). They found that xanthan and guar gums reduce gumminess in hamburger tissues.

Chewiness is the work required for chewing and preparing the sample for ingestion and is obtained by multiplying springiness by gumminess. The highest (0.51 kg/cm) and lowest (0.38 kg/cm) chewiness rates were obtained in treatments 3 (5% fat, 1% acacia, 4% water) and 5 (1.5% acacia, 8.5% water), respectively.

Collectively, the best results of tissue analysis were obtained in treatment 3 (5% fat, 1% acacia, 4% water). Adding herbal materials to meat products is, to a considerable extent, correlated with the interaction between these ingredients and meat muscular proteins (Feng and Xiong, 2003).

Chung and Huss (1999) reported that using xanthan and guar gums in a type of meatball (called Kung-wan) enhances hardness, cohesiveness and chewiness.

Choi et al (2009) stated that adding rice bran fiber improves tissue properties of meat batter and enhances hardness, cohesiveness and gumminess but has no effect on chewiness.

Alvarez et al (2012) reported that adding rice bran fiber and walnut associated with canola and olive oil in separate treatments increases tissue hardness, cohesiveness and gumminess in studied samples.

Choi et al (2015) found that adding rice bran fiber to Frankfurter sausage improves hardness, cohesiveness and gumminess but does not change chewiness. They reported that fiber addition enhances tissue properties of sausages.

Sensory analysis in various treatments

Undoubtedly, sensory properties of sausages are among the most important factors of acceptance by the consumers. Therefore, investigating sensory features respecting market acceptance of the product is of great significance. Moreover, sensory analysis guides the final acceptance of the product by evaluators. Hence, studying sensory properties is considered as a necessity (Jimenz et al, 1989).

In the present study, various sausage treatments were evaluated respecting color, odor, tissue, taste, and general acceptance. Sensory rates were as follows: 9(excellent), 7(good), 5(medium), 3(bad) and 1(inconsumable). Evaluation results are presented below.

Results of sensory analysis of product color and odor were similar and adding acacia had no impact on the two parameters. In these terms, all treatments rates excellent.

Parameters tissue, taste and general acceptance also led to similar results. Considering the results, adding acacia with different concentrations (1 and 1.5%) improved sensory properties of the sausage in

treatments 3 (5% fat, 1% acacia, 4% water) and 4 (5% fat, 1.5% acacia, 3.5% water). The best sensory results were observed in two mentioned treatments (with excellent sensory rate). The lowest sensory score was obtained for treatment 5 (1.5% acacia, 8.55 water).

Hosseini et al (2011) reported that referees evaluated low-fat hamburger samples containing cellulose microcrystalline as having better color and appearance than the control treatment.

Dehdashti et al (2016) stated that adding xanthan and guar gums has no effect on color, odor and taste of hamburger but improves its tissue.

Choi et al (2015) reported that adding rice bran fiber to Frankfurter sausage enhances its sensory properties.

Conclusion

Meat and its products are among valuable protein sources in human nutrition. Especially, these products are accepted by the public all around the world because of their consumption simplicity and taste diversity. But, a main problem is presence of high concentrations of fat in meat products including sausages. Therefore, it seems necessary to deliver low-fat and cholesterol products by adding fat substitutes including hydrocolloids. In this respect, the present paper investigated the effect of adding acacia to sausage formulations as a fat substitute and studied physicochemical, tissue and sensory properties of the product. Studied treatments included Treatment 1: the control treatment (no additives); Treatment 2: 5% fat, 0.5% acacia, 4.5% water; Treatment 3: 5% fat, 1% acacia, 4% water; Treatment 4: 5% fat, 1.5% acacia,3.5% water; and Treatment 5: 1.5% acacia, 8.5% water. Adding acacia enhances moisture, carbohydrate and ash contents, reduces fat content and leads to cooking loss of the sausage as compared to the control treatment. However, protein content was not significantly different among various treatments. Tissue analysis was performed through examining hardness, cohesiveness, springiness, chewiness and gumminess. The best tissue analysis results were obtained in Treatment 3 (5% fat, 1% acacia, 4%water). Moreover, adding acacia improved sausage sensory properties. The best sensory results were obtained in Treatments 3 (5% fat, 1% acacia, 4% water) and 4 (5% fat, 1.5% acacia, 3.5% water). According to results, it seems that adding acacia with 1% concentration improves sausage properties.

References

Borghe'ei. M., Baghaei, H., Motamedi, A. 2015. Substituting seed flour of chickpea and lentil in formulation of chicken cocktail wiener and examining physicochemical and sensory properties of the product. Journal and research and innovation in food science and industries. 4(4). 315-324.

Hosseini. F., Milani. A., Bolourian. S. 2011. The effect of cellulose microcrystalline a fat substitute on physicochemical, tissue and sensory properties of low-fat hamburger. Journal of food industries research. 21, 3, 371 – 378.

Abedini. M., Varidi. J., Shahidi. F., Marashi. S. 2009. Examining the effect of melon seed flour as fat substitute on physicochemical and sensory properties of meat products. Quarterly of food science and industries. 6(4), 51-58.

Lashkari. M., Keramat. J., Hashemi Ravan. M. 2008. The effect of adding potato diet fiber on chemical properties and organileptic quality of beef sausage. Nutrition and food industries. 9(4):49-60.

Razavi. Y., Ashgharpoor. A., Ariaei. P. 2011. The effect of adding *Satureja khuzestanica* extract on bacterial, chemical and sensory properties of Frankfurter sausage. Journal of research and innovation in food science and industries. 2(2), 279-294.

Hashemi Ravan. M., Shokrane. N. 2011. The effect of carboxymethyl cellulose substitute on chemical and tissue properties of German sausage. Nutrition and food sciences. 10(1):43-50.

Andre`s, S., Zaritzky, N. & Califano, A. 2006. The effect of whey protein concentrates and hydrocolloids on the texture and colour characteristics of chicken sausages.International Journal of Food Science and Technology. 41(8), 954-961.

Álvarez. D, Xiong Y.L., Castillo. M, Payne F.A., Garrido. M. D, 2012, Textural and viscoelastic properties of pork frankfurters containing canola–olive oils, rice bran, and walnut, *Meat Sci*. 92: 8- 15.

Banon, S., Diaz, P., Nieto, G., Castillo, M., & Alvarez, D. 2008. Modeling the yield and texture of comminuted pork products using color and temperature. Effect of fat/ lean ratio and starch. *Meat Science*, 80 (3), 649–655.

Choi YS, Choi JH, Han DJ, Kim HY, Lee MA, Kim HW, Jeong JY, Paik HD, Kim CJ. 2008. Effects of adding levels of rice bran fiber on the quality characteristics of ground pork meat product. *Korean J. Food Sci*. An. 28: 319-326.

Choi Y.S, Choi J.H, Han, Hack D.J- Kim Y, Lee M.A, Jeong J.Y, Chung H.J and Kim C.J, 2010. Effects of replacing pork back fat with vegetable oils and rice bran fiber on the quality of reduced-fat frankfurters. *Meat Science* 84:557-563.

Choi. Y, et al. 2015, Effects of fat levels and rice bran fiber on the chemical, textural, and sensory properties of frankfurters, *Food science and biotechnology*, 24(2):489-495.

Colmenero, F. J. 2000. Relevant factors in strategies for fat reduction in meat products. Journal of Trends in Food & Technology, 11,56-66.

Demirci. ZO, Yılmaz. I, Demirci. A. Ş, 2014, Effects of xanthan, guar, carrageenan and locust bean gum addition on physical, chemical and sensory properties of meatballs, J Food Sci Technol. 51(5):936-42.

Grigelmo-Miguel, N., Abadias-Seros, M. I. & Martin-Belloso, O. 1999. Characterization of Low-Fat High-Dietary Fiber Frankfurter. Meat Science, 52, 247-256.

Hayes, J.E., StePanyan. V., Allen, P., O'Grady, M.N., & Kerry, J.P. 2011. Evaluation of the effects of selected plant-derived nutraceuticals on the quality and shelf-life stability of raw and cooked pork sausages. LWT-Food Science and Technology, 44: 164-172.

Hughes, E., Cofrades, S., & Troy, D. J. 1997. Effects of fat level, oat fiber and carrageenan on frankfurters formulated with 5%, 12% and 30% fat. *Meat Science*, 45(3), 273–281.

Hsia, H. Y., Smith, D. M. & Steffe, J. F. 1992. Rheological properties and adhesion characteristics of flour-based batters for chicken nuggets as affected by three hydrocolloids.Journal of food science. 57(1), 16-24.

Hsu, S. Y. & Chung, H. Y. (1999). Comparisons of 13 edible gum-hydrate fat substitutes for low fat kung-wan (an emulsifed meatball). Journal of food engineering. 40(4), 279-285.

Ilıkkan, H., Ercos. ß, kun, H., Vural, H., & S ßahin, E. 2009. The effect of addition of hazelnut oil on some quality characteristics of Turkish fermented sausage (sucuk). *Journal of Muscle Foods*, 20, 117–127.

Jimenez L; Ferrer L. And paniego. ML. 1989. J. Food Eng. P. 119-128.

Marchetti, L., Andrés, S. C. & Califano, A. N. 2013. Textural and thermal properties of low-lipid meat emulsions formulated with fish oil and different binders. Journal of Food Science and Technology. 51(2), 514-523.

Szczesniak, A.S. 2002. Texture is a sensory property. Journal of food quality and preference. 13: 215–225.

Tokusoglu, O. & Kemalunal, M. (2003).Fat Replacers in Meat Products. Pakistan Journal of Nutrition, 2:196-203.Venugopal, V. 2006. Sea food processing, adding value through quick freezing, retortable packaging cook- chilling. Taylor Francis group press. P: 485.

Zhou, W. W., Meng, L., Li, X., Ma, L. & Dai, R. 2010. Effect of the interaction between carrageenan, gellan gum and flaxseed gum on quality attributes of starch-free emulsion-type sausage. Journal of muscle foods. 21(2), 255-267.