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BINDERS AS FUNCTIONAL INGREDIENTS IN MEAT PRODUCTS - AN OVERVIEW

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ABSTRACT

The article evaluates the effect of binders as functional ingredient in meat products and their physiological role in human health. Fibers are naturally occurring compounds present in variety of vegetables, fruits, cereal flours etc in abundance, and act through their solubility, viscosity, gel forming ability, water-binding capacity, oil adsorption capacity, ferment ability, and mineral and organic molecule binding capacity which affect product quality and characteristics. Beside these, high-fiber intake tends to reduce risk of colon cancer, obesity, cardiovascular diseases, and several other disorders. Moreover, based on their physiochemical properties, many fibers can help to improve colour, texture and sensorial characteristics instead of nutritional benefits. Fiber inclusions could help in diminution of calorie content in foods.

INTRODUCTION

Recently consumers are increasingly interested about health oriented functional meat products. According to them, food they consume should not only taste better, but also be attractive, safe and healthy. Consumers are getting educated with nutritional information available through different sources. Presently, consumers are very concern about their diet and the food they eat and attention has been diverted toward processed meat products that are lean, low fat and high in protein content (Bhaskar Reddy *et al.,* 2012). This powerful influence of diet on health and wellbeing and increasing scientific evidence confirms that specific components in diet may tend to reduce the occurrence of certain chronic diseases such as cardiovascular diseases, various cancers and neurological disorders (Ames *et al.,* 1993). It has revitalized the interests not only in consumer, but also among researchers and meat food product processors to develop formulated products, which are "natural, functional and nutritional" as well. Functional meat products either possess nutritional ingredients that improve health or contain lesser quantity of harmful compounds like cholesterol and fat etc., (Yue, 2001).

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These products are generally produced by reformulation of meat by incorporating health producing ingredients like variety of fibers, protein, polyunsaturated fatty acids (PUFA), antioxidants etc. Meat products which contain dietary fibers are excellent meat substitutes due to their inherent functional and nutritional effects (Hur *et al.,* 2009).

Further, dietary fiber intake through meat reduces plasma and LDL-cholesterol, reduce the risk of major dietary problems such as obesity, coronary diseases, diabetes, gastrointestinal disorders, including constipation, inflammatory bowel diseases etc (Schneeman, 1999). Besides health benefit effects, dietary fiber supplementations increase the bulk and prevent cooking loss in meat products with fewer changes in textural parameters by enhancing water binding capabilities and carries great economic advantages for both the consumers and processors (Grigelmo- Miguel *et al.,* 1999).

EXTENDERS/FILLERS/BINDERS

Non meat products derived from a variety of plant and animal sources are used extensively as fillers, binders and extenders in comminuted meat systems to improve the quality and to reduce the production cost. Their prudent incorporation results in improvement of the quality of meat products.

Effect of binders on the physico chemical parameters of meat and meat products

Cooking Loss

Hughes *et al.* (1997) studied the effects of fat level, oat fibre and carrageenan on frankfurters formulated with 5, 12 and 30 % fat and concluded that addition of oat fibre and carrageenan reduces the cooking loss. Huang *et al.* (1999) studied the functional properties of sorghum flour as an extender in ground beef patties and concluded that beef patties containing sorghum flour had greater yield, less total cooking loss when compared to control and fat and water retentions of beef patties increased as the level of sorghum flour increased. Oat was added by Steenblock *et al.* (2001) to determine the effects on the quality characteristics of light bologna and fat free frankfurters and concluded that the addition of oat fiber improves the product yield. Morin *et al.* (2004) studied the interactions between meat proteins and barley β-glucan within a reduced-fat breakfast sausage system and concluded that 0.8% β-glucan treatment showed lower ($P \leq 0.05$) cooking loss compared to control and 0.3% β-glucan. Yang *et al.* (2007) evaluated the textural and sensory properties of low fat sausages by adding hydrated oat meal and tofu and showed that higher levels of hydrated oat meal reduced the cooking loss.

Pinero *et al.,* (2008) studied the effects of oat's soluble fibre (β-glucan-13.45%) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties and concluded that cooking yield was significantly ($P<0.001$) higher in patties formulated with oat soluble fibre when compared to control. Modi *et al.* (2008) studied the effect of carrageenan (0.5-1.5%) and oat flour (8%) on quality characteristics of meat kofta and states that inclusion of oat flour and carrageenan in the formulation resulted in significant ($P<0.05$) higher yield upon cooking and frying. Yang *et al.* (2009) evaluated the properties of duck meat sausages supplemented with cereal flours and concluded that the cooking loss was not significantly different among sausage batters and cooking loss of wheat batter was significantly lower than those of barley, corn and millet batters. Prasad *et al.* (2011) studied that chicken kofta prepared by using minced meat (72%) and optimized quantities of oat flour (8%), casein (2.5%) and refined wheat flour (7%) resulted in higher ($P \leq 0.05$) yield and lower fat ($P \leq 0.05$) as compared with control.

Das *et al.* (2011) studied the effect of sorghum flour and finger millet flour as fat replacers in low cost chicken patties and concluded that higher cooking yield was observed in sorghum flour treated patties when compared to those prepared with finger millet flour and control without any flour. Devatkal *et al.* (2011) studied the quality characteristics of gluten-free chicken nuggets extended with sorghum flour and concluded that sorghum flour significantly ($P < 0.05$) increased the product yield as compared with control. Kurt and Osman Kilincceker (2012) studied the effect of cereal (wheat, barley, oat, corn) and legume flours (soy, chick pea, yellow lentil flours) on the quality characteristics of beef patties at 5% level, and reported oat flour has got a non-significant increase in moisture retention, and cooking yield than corn flour beef patties. Alvarez and Barbut (2013) established that increasing the level of β-Glucan which is the soluble fiber in oats, in cooked meat batters resulted in a significant decrease in cooking losses. Santhi and Kalaikannan (2014) studied the effect of addition of oat flour in low-fat chicken Nuggets and concluded that the cooking yield was significantly higher in the nuggets containing OF.

Emulsion Stability

Bhoyar *et al.* (1996) found that incorporation of texturized soy protein brought significant improvement in emulsion stability and further observed that the emulsion stability containing 20% textured soy protein was most stable and no further improvement was noticed by substituting textured soy protein beyond 20% in restructured chicken steaks. Hughes *et al.* (1997) studied the effects of fat level, oat fibre (2%) and carrageenan (1%) on frankfurters formulated with 5, 12 and 30 % fat and concluded that addition of oat fibre and carrageenan increases the emulsion stability. Bhoyar *et al.* (1997) stated that incorporation of 20% texturized soy protein and 10% milk co–precipitates in restructured chicken steaks have greater emulsion stability than control and other formulations. Rao *et al.* (1997) studied the emulsion stability of batter with sodium caseinate, refined wheat flour and calcium caseinate and found that refined wheat flour was significantly higher than those with caseinate and refined wheat flour alone. Wheat flour has been reported to stabilize the emulsion through gelatinization of its starch components, while caseinates improve the stability due to their richness in hydrophilic as well as lipophilic binding sites. Nag *et al.* (1998) revealed that there was a significant ($P<0.05$) improvement in the emulsion stability of spent hen meat nuggets extended with rice flour from 0 to 15% levels. Kumar and Sharma (2005) indicated that the emulsion stability of spent hen meat patties extended with pressed rice flour significantly ($P<0.05$) increased up to 10% and no further increase was noticed even up to 15% level.

Rajendran Thomas *et al.* (2006) observed that the emulsion stability of restructured buffalo meat nuggets was significantly ($P<0.05$) lower than that of the emulsion form of nuggets. The lower stability for restructured buffalo meat nuggets might be attributed to its higher moisture content and absence of added fat. Kalaikannan *et al.* (2007) concluded that incorporation of whole egg powder, dried albumen and dried yolk significantly ($P<0.05$) improved the emulsion stability of broiler spent hen meat patties compared with the control samples and even though there was an improvement in the emulsion stability in the liquid egg added samples, the difference over the control was not significant. Dushyanthan *et al.* (2008) studied the processing of buffalo meat nuggets utilizing different binders like maida, soy flour, whole egg and liquid whey each at different levels and stated that 7% maida, and 1% whole egg, 3% soy flour and 3% liquid whey have highest emulsion stability. Talukder and Sharma (2010) developed dietary fiber rich chicken meat patties by incorporating wheat and oat bran at 5, 10, 15 % levels and reported increase in cooking yield. Eating quality and physico-chemical properties of fresh Emu meat sausages prepared in comparison with broiler and spent hen meat sausages with oat flour and corn flour was studied by Govind *et al*. (2013) and found that Emu meat sausages recorded significantly ($p<0.05$) higher emulsion stability and water holding capacity.

Water-Holding Capacity

Hughes *et al.* (1997) studied the effects of fat level, oat fibre (2%) and carrageenan (1%) on frankfurters formulated with 5, 12 and 30 % fat and concluded that addition of oat fibre and carrageenan increased the water holding capacity. Reddy *et al.* (1999) stated that incorporation of soy flour in mutton sausages had the highest water holding capacity followed by bengal gram flour, corn flour and skim milk powder and lowest water holding capacity was observed in control sausages which is due to salt soluble protein of non meat proteins which influences the water holding capacity. Morin *et al.* (2004) studied the interactions between meat proteins and barley β-glucan within a reduced-fat breakfast sausage system and concluded that 0.3% β-glucan treatment showed higher water binding ability compared to 0.8% β-glucan. The quality of low-fat beef meat balls containing legume flours as extenders was studied by Serdaroglu *et al.* (2005) and stated that beef meat balls extended with blackeye bean flour, chickpea flour, lentil flour have higher water-holding capacity than meat balls extended with rusk.

Yang *et al.* (2007) evaluated the textural and sensory properties of low fat sausages by adding hydrated oat meal and tofu and concluded that addition of oat meal increases the water holding capacity and increases with increased levels of oat meal. Modi *et al.* (2008) studied the effect of carrageenan (0.5-1.5%) and oat flour (8%) on quality characteristics of meat kofta and stated that uncooked and cooked meat kofta had higher ($P< 0.05$) WHC than control. Sharaf *et al.* (2009) conducted a research to use defatted-detoxified moringa meal as meat extender in the preparation of beef burgers instead of soy bean flour and stated that beef burger patties prepared with defatted detoxified moringa meal resulted in increased water holding capacity. Eating quality and physico-chemical properties of fresh Emu meat sausages prepared in comparison with broiler and spent hen meat sausages with oat flour and corn flour was studied by Govind *et al*. (2013) and found that Emu meat sausages recorded significantly ($p<0.05$) higher emulsion stability and water holding capacity.

Effect of binders on the proximate analysis of meat and meat products

Per Cent Moisture

Modi *et al.* (2003) studied the quality of buffalo meat burgers extended with various legume flours and concluded that the burgers prepared using different binders before frying had 10% more moisture than those burgers after frying. Biswas *et al.* (2004) conducted a trail on the effect of enrobing and antioxidants on the quality characteristics of precooked pork patties under chilled and frozen storage conditions and noticed significant difference in moisture loss after 7 days of storage at 4ºC in enrobed pork patties. Serdaroglu (2006) studied the characteristics of beef patties containing different levels of fat and oat flour and concluded that moisture content was decreased in raw patties as a result of the addition of oat flour but increases the moisture content in cooked patties. Yang *et al.* (2007) evaluated the textural and sensory properties of low fat sausages by adding hydrated oat meal and tofu and concluded that moisture content was similar among sausages and there was no significant difference among sausage samples. Das *et al.* (2008) prepared goat meat nuggets with full-fat soy paste and textured soy granules to evaluate their effect on quality and shelf-life during frozen storage and stated that the per cent moisture was more in goat meat nuggets prepared with soy granules than in control and soy paste incorporated patties. Pinero *et al.* (2008) studied the effects of oat's soluble fibre as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties and concluded that percent moisture retention and moisture content was significantly ($P < 0.001$) higher in patties formulated with oat soluble fibre when compared to control. Modi *et al.* (2008) studied the effect of carrageenan and oat flour (8%) on quality characteristics of meat kofta and stated that inclusion of oat flour and carrageenan in the formulation resulted in significantly ($P < 0.05$) higher moisture retention upon cooking and frying.

Modi *et al.* (2009) studied the effect of carrageenan (0.5%) and oat flour (8%) on storage characteristics of fried mutton kofta and state that inclusion of oat flour and carrageenan resulted in substantially higher moisture content compared with control. Yang *et al.* (2009) evaluated the properties of duck meat sausages supplemented with cereal flours and stated that the moisture content did not vary significantly among sausage batters with added cereal flours. Kurt and Osman Kilincceker (2012) studied the effect of cereal (wheat, barley, oat, corn) and legume flours (soy, chick pea, yellow lentil flours) on the quality characteristics of beef patties at 5% level, and reported oat flour has got a non-significant increase in moisture retention, and cooking yield than corn flour beef patties. Santhi and Kalaikannan (2014) studied the effect of addition of oat flour in low-fat chicken nuggets and concluded that the increased OF levels resulted in a significant increase in moisture, crude fiber and gross energy and a decrease in the percentage of crude protein and fat.

Per Cent Protein

Hughes *et al.* (1997) studied the effects of fat level, oat fibre (2%) and carrageenan (1%) on frankfurters formulated with 5, 12 and 30 % fat and concluded that protein concentration in 5% fat formulation was slightly higher than in remaining treatments. Kerr *et al.* (2005) a decrease in crude protein and fat levels was observed with increase in the levels of OF which may be attributed to the contribution of carbohydrates from OF where the protein and fat content of oats is lower than that of meat. Serdaroglu (2006) studied the characteristics of beef patties containing different levels of fat and oat flour and concluded that oat flour addition did not change the protein content of either raw or cooked patties. Yang *et al.* (2007) evaluated the textural and sensory properties of low fat sausages by adding hydrated oat meal and tofu and concluded that addition of oat meal decreased the protein content. Pinero *et al.* (2008) studied the effects of oat's soluble fibre (β-glucan-13.45%) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties and concluded that no significant difference was observed between patties formulated with oat soluble fibre and control. Yang *et al.* (2009) evaluated the properties of duck meat sausages supplemented with cereal flours and concluded that the protein content differed among the sausage batters and was

significantly lower in batters with added cereal flours when compared with control batter. Santhi and Kalaikannan (2014) studied the effect of addition of oat flour in low-fat chicken nuggets and concluded that the increased OF levels resulted in a significant increase in moisture, crude fiber and gross energy and a decrease in the percentage of crude protein and fat.

Per Cent Fat

Hughes *et al.* (1997) studied the effects of fat level, oat fibre (2%) and carrageenan (1%) on frankfurters formulated with 5, 12 and 30 % fat and concluded that addition of oat fibre or carrageenan did not affect the fat content of the cooked products. Sampaio *et al.* (2004) studied the effect of fat replacers on the nutritive value and acceptability of beef frankfurters and found that reduced fat content in sausages when oat bran, carrageenan, and cassava starch were added to beef frankfurters. Kerr *et al.* (2005) a decrease in crude protein and fat levels was observed with increase in the levels of OF which may be attributed to the contribution of carbohydrates from OF where the protein and fat content of oats is lower than that of meat. Serdaroglu (2006) studied the characteristics of beef patties containing different levels of fat and oat flour and concluded that oat flour addition did not change the fat content of either raw or cooked patties. Yang *et al.* (2007) evaluated the textural and sensory properties of low fat sausages by addition of hydrated oat meal and tofu and concluded that addition of oat meal and tofu decreased the fat content.

Pinero *et al.* (2008) studied the effects of oat's soluble fibre as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties and concluded that fat content was significantly ($P<0.05$) lower in patties formulated with oat soluble fibre when compared to control. Modi *et al*. (2009) studied the effect of carrageenan (0.5%) and oat flour (8%) on storage characteristics of fried mutton kofta and stated that inclusion of oat flour and carrageenan resulted in substantially lower contents of fat compared with control. Yang *et al.* (2009) evaluated the properties of duck meat sausages supplemented with cereal flours and concluded that the fat content was significantly lower in all sausage batters with added cereal flours ($P < 0.05$). Prasad *et al.* (2011) studied that chicken kofta prepared by using minced meat and optimized quantities of oat flour (8%), casein (2.5%) and refined wheat flour (7%) resulted in lower fat ($P \leq 0.05$) when compared with control. Santhi and Kalaikannan (2014) studied the effect of addition of oat flour in low-fat chicken nuggets and concluded that the increased OF levels resulted in a significant increase in moisture, crude fiber and gross energy and a decrease in the percentage of crude protein and fat.

Percent Crude Fiber

Prasad *et al.* (2011) studied about the chicken kofta prepared by using minced meat and optimized quantities of oat flour (8%), casein (2.5%) and refined wheat flour and stated that treatments with oat flour increased the fiber levels in meat products. Devatkal *et al.* (2011) studied the quality characteristics of gluten-free chicken nuggets extended with sorghum flour and concluded that sorghum flour significantly ($P < 0.05$) increased the dietary fiber content when compared with control. Santhi and Kalaikannan (2014) studied the effect of addition of oat flour in low-fat chicken nuggets and concluded that the increased OF levels resulted in a significant increase in moisture, crude fiber and gross energy and a decrease in the percentage of crude protein and fat.

Effect of binders on Organoleptic evaluation of meat and meat products

Lapvetelainen *et al*. (1994) assesses the functionality of oat flour in bread and sausages and concluded that sausages containing oat flour were less firm and juicy than the control and flavour of the sausages was improved. Hughes *et al*. (1997) studied the effects of fat level, oat fibre (2%) and carrageenan (1%) on frankfurters formulated with 5, 12 and 30 % fat and concluded that addition of oat fibre or carrageenan did not alter the color of the frankfurters and neither ingredient had a significant effect on the flavour. Chang and Carpenter (1997) found that oat bran and oat fibre improved the flavour, texture and mouth feel in ground beef and pork frankfurters. Warner and Inglett (1997) observed that the use of oat fibre Z-trim or Z-trim or oat trim-5 blend to fat free ground beef increased juiciness compared to the control. Desmond and Troy (1998) compared the non meat adjuncts used in manufacture of low fat beef burgers and stated that addition of oat fibre improved the taste and total quality of the final products. Huang *et al.* (1999) studied the functional properties of sorghum flour as an extender in ground beef patties and concluded that tenderness, aroma and flavour of cooked patties increased as the level of sorghum flour increased, but juiciness of cooked patties was not affected. Troy *et al*. (1999) studied the eating quality of low-fat beef burgers containing fat-replacing functional blends and stated that oat fibre can be used to prevent the poor quality associated with low-fat beef burgers.

Garcia *et al.* (2002) studied the effect of oat bran and oat fiber in ground beef and low fat dry fermented sausages and concluded that the oat bran and oat fiber provide the flavour and texture. Carbonell *et al.* (2005) evaluated the functional and sensory effects of fibre-rich ingredients on breakfast fresh sausages and stated that sausages containing oat and wheat rusk or oat, wheat rusk and albedo (together) showed the highest score in overall acceptance. Serdaroglu (2006) studied the characteristics of beef patties containing different levels of fat and oat flour and concluded 4% oat flour increased the juiciness scores. Yang *et al.* (2007) evaluated the textural and sensory properties of low fat sausages by adding hydrated oat meal and tofu and concluded that addition of oat meal improved the flavour scores, tenderness, juiciness and maximum acceptability score was obtained with 15% hydrated oat meal. Pinero *et al.* (2008) studied the effects of oat's soluble fibre (β-glucan-13.45%) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties and concluded that patties formulated with oat soluble fibre were more significantly ($P < 0.05$) juicy when compared to control. Modi *et al.* (2008) studied the effect of carrageenan (0.5-1.5%) and oat flour (8%) on quality characteristics of meat kofta and stated that cooked kofta had a better juiciness than control. Yang *et al.* (2009) evaluated the properties of duck meat sausages supplemented with cereal flours and concluded that the acceptability of duck sausages

could be enhanced by addition of cereal flours and desirable low-fat duck sausage can be produced if 10% of meat content is replaced with cereal flours, thereby reducing the off-flavour associated with pure duck meat. Modi *et al.* (2009) studied the effect of carrageenan (0.5%) and oat flour (8%) on storage characteristics of fried mutton kofta and stated that inclusion of oat flour and carrageenan resulted in decrease in sensory attributes when stored for 6 weeks at 4±2ºC. Prasad *et al.* (2011) studied that chicken kofta prepared by using minced meat (72%) and optimized quantities of oat flour (8%), casein (2.5%) and refined wheat flour and stated that sensory quality was acceptable and retains the natural flavor of meat during the 15 days of refrigerated storage. Devatkal *et al.* (2011) studied the quality characteristics of gluten-free chicken nuggets extended with sorghum flour and concluded that 5% sorghum flour had better sensory scores as compared to 10 % and control. Kumar *et al.* (2013) showed that addition of green banana and soybean hulls flours in chicken nuggets improved their quality and storage stability. Santhi and Kalaikannan (2014) studied the effect of addition of oat flour in low-fat chicken nuggets and concluded that the juiciness score increased, whereas the texture and flavor scores and overall acceptability decreased with the increased levels OF inclusion.

Conclusion

Meat and meat products can be modified by adding fibre sources to decrease the possibility of chronic diseases associated with them. The use of these ingredients in meat products offers processors the opportunity to improve the nutritional and health qualities of their products.

REFERENCES

Álvarez, D., Barbut, S. 2013. Effect of Inulin, β-Glucan and their mixtures on emulsion stability, color and textural parameters of cooked meat batters. *Meat Sci* 94: 320-327.

Ames, B. N., Shigenaga, M. K. and Hagen, T. M. 1993. Oxidants, antioxidants and the degenerative disease of aging. *Proc. Natl. Acad. Sci.,* 90:7915-7922.

Bhaskar Reddy, G.V., Shashi Kumar, M., Gupta, R.S., Kiran, M. and Kondal Reddy, K. 2012. Effect of Oat flour on Quality Characteristics of Low-Fat Chicken Sausages. *Journal of Meat Science,* 8(1&2): 8-15.

Bhoyar, A. M., Pandey, N. K., Anand, S. K. and Verma, S. S. 1996. Development of restructured chicken steaks using texturized soya protein as extender. *Indian Food Packer* July-Aug : 15-22.

Bhoyar, A. M., Pandey, N. K., Anand, S. K. and Verma, S. S. 1997. Effect of incorporating texturized soy protein and milk co precipitates on the quality characteristics of restructured chicken steaks. *Indian Journal of Poultry Science* 32(3): 253-258.

Biswas, A. K., Keshri, R. C. and Bisht, G. S. 2004. Effect of enrobing and antioxidants on quality characteristics of precooked pork patties under chilled and frozen storage conditions. *Meat Science* 66 (3): 733-741.

Carbonell, L. A., Lopez, J. F., Alvarez, J. A. P. and Kuri, V. 2005. Functional and sensory effects of fibre-rich ingredients on breakfast fresh sausages manufacture. *Food Science and Technology International.* 11 (2): 89-97

Chang, H. C. and Carpenter, J. A. 1997. Optimizing quality of frankfurters containing oat bran and adder water. *Journal of Food Science* 62:194–197.

Das, A. K., 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* 80: 607-614.

Das, S. K., Pazhaniandi, P. P., Tanwar, V. K., Biswas, S. and Khan, A. 2011. Effect of sorghum flour and finger millet flour as fat replacers for preparing low cost chicken. FLEISCHWIRTSCHAFT International 26(3):64-68.

Desmond, E. M. and Troy, D. J. 1998. Comparative studies of non meat adjuncts used in manufacture of low fat beef burgers. *Journal of Muscle Foods*. 9:221-241

Devatkal, S., Kadam, D., Naik, P. and Sahoo, J. 2011. Quality characteristics of gluten free chicken nuggets extended with sorghum flour. *Journal of Food Quality* 34(2): 88–92.

Dushyanthan, K., Narendrababu, R., Vasanthi, C. and Venkataramanujan, V. 2008. Processing of buffalo meat nuggets utilizing different binders. *Tamilnadu Journal of Veterinary and Animal Science* 4(2):77-83.

Garcia, M. L., Dominguez, R., Galvez, M. D., Casas, C. and Selgas, M. D. 2002. Utilization of cereal and fruit fibres in low fat dry fermented sausages. *Meat science* 60:227-236.

Grigelmo-Miguel, N., Abadias-Seros, M. and Martin-Belloso, O. 1999. Characterization of low fat high-dietary fiber frankfurters. *Meat Sci*., 52: 247-256.

Govind, V., Prabhakar, K., Eswara Rao, B. and Naga Mallika, E. 2013. Eating quality and physico-chemical properties of fresh emu meat sausages prepared in comparison with broiler and spent hen meat sausages with oat flour and corn flour. *International Journal of Food, Agriculture and Veterinary Sciences*. Vol. 3 (1): 247-253.

Huang, J. C., Zayas, J. F. and Bowers, J. A. 1999. Functional properties of sorghum flour as extender in ground beef patties. *Journal of Food Quality* 22 (1): 51–61.

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

Hur, S. J., Lim, B. O., Park, G. B. and Joo, S. T. 2009. Effect of various fiber additions on lipid digestion during in *vitro* digestion of beef patties. *J. Food Sci*., 74(9): 653-657.

Kalaikannan, K., Anjaneyulu, A. S. R. and Shanthi, D. 2007. Effect of egg proteins on the quality and refrigerated storage life of chicken patties made with broiler, spent hen meat and by products. *International Journal of Food Science and Technology* 42: 579-586.

Kerr, WL., Wang, X., Choi, SG. 2005. Physical and sensory characteristics of lowfat Italian sausage prepared with hydrated oat. *J Food Qual* 28: 62-77.

Kumar, R. R. and Sharma, B. D. 2005. Evaluation of the efficacy of pressed rice flour as extender in chicken patties. *Indian Journal of Poultry Science* 40(2): 165-168.

Kumar, V., Biswas, AK., Sahoo, J., Chatli, MK., Sivakumar, S. 2013. Quality and storability of chicken nuggets formulated with green banana and soybean hulls flours. *J Food Sci Technol* 50: 1058-1068.

Kurt Sukuru, Osman Kilincceker, 2012. The Effects of cereal and legume flours on the quality characteristics of beef patties, Kafkas Univ Vet Fak Derg 18(5):725-730.

Lapvetelainen, A., Puolanne, E. and Salovaara, H. 1994. High protein oat flour functionality assessment in bread and sausage. *Journal of Food Science* 59(5) 1081–1085.

Modi, V. K., Mahendrakar, N. S., Narasimha Rao, D. and Sachindra, N. M. 2003. Quality of buffalo meat burger containing legume flours as binders. *Meat Science* 66 (1): 143-149.

Modi, V. K., Yashoda, K. P. and Naveen, S. K. 2008. Effect of carrageenan and oat flour on quality characteristics of meat kofta. *International Journal of Food Properties* 12(1): 228-242.

Modi, V. K., Yashoda, K. P., Bhaskar, N. and Mahendrakar, N. S. 2009. Effect of carrageenan and oat flour on storage characteristics of fried mutton kofta. *Journal of Food Processing and Preservation* 33(6): 763–776.

Morin, L. A., Temelli, F. and McMullen, L. 2004. Interactions between meat proteins and barley (Hordeum spp.) β-glucan within a reduced-fat breakfast sausage system. *Meat science* 68: 419-430.

Nag, S., Sharma, B. D. and Kumar, S. 1998. Quality attributes and shelf life of chicken nuggets extended with rice flour. *Indian Journal of Poultry Science* 33 (2): 182-186.

Pinero, M. P., Parra, K., Leidenz, N. H., Arenas De Moreno, L., Ferrer, M., Araujo, S. and Barboza, Y. 2008. Effects of oat's soluble fibre(β-glucan) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties. *Meat Science* 80:675-680.

Prasad, B., Rashmi, M., Ysshoda, K. and Modi, V. 2011. Effect of casein and oat flour on physico chemical and oxidative processes of cooked chicken kofta. *Journal of Food Processing and Preservation* 35(3): 359–368.

Rajendran Thomas, Anjaneyulu, A. S. R., Kondaiah, N. 2006. Quality and shelf life evaluation of emulsion and restructured buffalo meat nuggets at cold storage (4+10C). *Meat Science* 72: 373-379.

Rao, K. H., Singh, R. R. B., Anjaneyulu, A. S. R., Rao, K. V. V. S. and Yadav, P. L. 1997. Effect of caseinates and refined wheat flour on the quality of chicken nuggets from spent hens. *Indian Journal of Animal Science* 67(11): 1004-1006.

Reddy, N. S. P., Reddy, M. S. and Reddy, K. S. 1999. Influence of inclusion of non-meat extenders in mutton sausages on its quality. Indian Food Packer March-April: 20-21.

Sampaio, G. R., Claudia, C. M. N., Castellucci, M. N., Pinto de Silva, M. E. M. and Torres, E. A. F. S. 2004. Effect of fat replacers on the nutritive value and acceptability of beef frankfurters. *J. Food Compost. Anal.* 17:469–474.

Santhi, D., Kalaikannan, A. 2014. The Effect of the Addition of Oat Flour in Low-Fat Chicken Nuggets. *J Nutr Food Sci* 4: 260. doi: 10.4172/2155- 9600.1000260.

Schneeman, B. O. 1999. Fiber, inulin and oligofructose: Similarities and differences. J. Nutr., 129: 1424-1427.

Serdaroglu, M., Turp, G. Y. and Abrodimov, K. 2005. Quality of low-fat meat balls containing legume flours as extenders. *Meat Science* 70 (1): 99-105.

Serdaroglu, M. 2006. The characteristics of beef patties containing different levels of fat and oat flour. *International Journal of Food Science & Technology* 41(2): 147–153

Sharaf, A. M., Ebrahium, M. E., Ammar, M. S. and Abd El-Ghany, M. E. 2009. Influence of Using Moringa Meal Flour as Meat Extender on Quality Characteristics of Beef Burger Patties During Frozen Storage. *World Journal of Dairy & Food Sciences* 4 (1): 32-40.

Steenblock, R. L., Sebranek, J. G., Olson, D. G. and Love, J. A. 2001. The effects of oat fiber on the properties of light bologna and fat free frankfurters. *Journal of food science* 66(9):1409-1415.

Talukder, S. and Sharma, D. P. 2010. Development of dietary fibre rich chicken meat patties using wheat and oat bran, J Food SciTechnol 47 (2): 224-229.

Troy, D. J., Desmond, E. M. and Buckly, D. J. 1999. Eating quality of low-fat beef burgers containing fat-replacing functional blends. *Journal of the Science of Food and Agriculture*. 79:507-516.

Warner, K. and Inglett, G. 1997. Flavor and texture characteristics of foods containing z-trim corn and oat fibers as fat and flour replace. *Cereal Food World*. 42(10):821-825.

Yang, H. S., Choi, S. G., Jeon, J. T., Park and Joo, S. T. 2007. Textural and sensory properties of low fat pork sausages with added hydrated oat meal and tofu as texture – modifying agents. *Meat Science* 75:283-289.

Yang, H. S., Ali, M. S., Jeong, J. Y., Moon, S. H., Hwang, Y. H., Park, G. B. and Joo, S. T. 2009. Properties of duck meat sausages supplemented with cereal flours. *Poultry Science* 88 (7): 1452-1458.

Yue Xu, 2001. Perspectives on the 21st century development of functional foods: Bridging Chinese medicated diet and functional foods. *Int. J. Food Sci. Technol*., 36: 229-242

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