American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

American Journal of Food Technology 2 (1): 38-43, 2007
ISSN 1557-4571

Studies on Processing and Shelf Life of Pork Nuggets with Liquid Whey as a Replacer for Added Water

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Abstract: A study on the preparation and assessment of physico-chemical, microbiological and organoleptic properties of pork nuggets was carried out using liquid whey as a replacement for added water at three different levels viz., 20, 30 and 40%. Based on the physico-chemical and organoleptic evaluation 20% liquid whey as a water replacer was selected and shelf life studies was carried out. A significant ($p<0.01$) difference was evident in terms of pH, TBARS value, tyrosine value and organoleptic evaluation during storage period. Also total viable count, staphylococcal count and yeast and mould count revealed a highly significant ($p<0.01$) difference during storage period. Further, the pork nuggets were well acceptable upto 14 days of storage at refrigerated temperature (4±1°C) by the panelists. By incorporating liquid whey in the comminuted meat products the most desirable quality pork nuggets can be developed with additional advantage of fortification, excluding the drying expenses to produce whey protein concentrates and elimination of environmental pollution due to draining of surplus liquid whey.

Key words: Pork nuggets, liquid whey, microbial quality, physico-chemical characteristics, storage

Introduction

In India with rapid strides being made in industrialization and urbanization, food habits and consumer preferences are changing with more women taking outdoor jobs, thereby creating the necessity of providing processed, ready to eat and serve convenient food including meat products. Processed meat sector plays a major role in providing variety of meat products with increasing demand and better marketability the utilization of different cuts and by products in meat products is becoming important.

Whey is a by-product of cheese and casein manufacture and contains approximately 20% of the original milk protein (McIntosh *et al*., 1998). Several workers tried whey protein concentrate in emulsion type meat products such as frankfurters and bologna sausages (Hung and Zayas, 1992; Lyons *et al*., 1999; Serdaroglu and Sapanci Ozsumer, 2003; Serdaroglu and Deniz, 2004; Yetim *et al*., 2001).

The liquid whey had the proximate composition of 93% water, 7% solids which includes 5% lactose, 1% protein and 1% minerals. Eventhough liquid whey is nutritionally rich containing 50% of the nutrients of the whole milk, it is considered an expensive and frustrating disposal problem and often dumped because of high cost of concentrating or drying (Kosikowski, 1982). Whey proteins are an excellent source of essential amino acids, particularly lysine, which may be beneficial in

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frankfurter manufacture, resulting in a more balanced amino acid composition than with full meat controls (Lee *et al*., 1980).

A tremendous need exists to utilize whey proteins or products in food processing to prevent wasting this valuable protein and mineral source. Several workers have replaced water with liquid whey in restructured boneless ham cure formulations and reported up to 30% liquid whey may successfully be incorporated in to cured ham formulations and resulted in similar appearance, flavor and stability as non-whey controls (Marriott *et al*., 1998). Mostly by utilizing more expensive Whey Protein Concentrates (WPC) or dried whey powders or protein hydrolysates, the comminuted meat products were produced. The use of liquid whey which is cheaper, environmental friendly and by product of cheese industry in the meat products is not fully explored yet. Therefore this experiment was designed to explore the possibility of using liquid whey as a replacement to added water into pork nuggets and its effect on storage stability of the product at refrigeration temperature (4±1°C).

Materials and Methods

A study on the preparation and assessment of physico-chemical, microbiological and organoleptic properties of pork nuggets was carried out using liquid whey as a binder and water replacer at three different levels viz., 20, 30 and 40% of added water. Hot deboned pork and pork fat was obtained from the pigs slaughtered at the Department of Meat Science and Technology, Madras Veterinary College, Chennai, India. The lean meat and fat were cut in to small pieces and were packed in polyethylene bags separately and frozen at -20°C until use. A total of twelve batches of pork nuggets were prepared in this study. Out of this six batches were used for standardization. The pork nuggets were prepared with the following recipe. Pork-800 g, pork fat-200 g, salt-20 g, added water-100 g, sodium nitrite -0.12 g, sodium tripolyphosphate-3 g, spice mix-15 g and green condiments-40 g (onion-30 g and garlic-10 g). In the above recipe liquid whey was used to replace the added water at three different levels viz., 20, 30 and 40%. This liquid whey along with added water was formed in to ice flakes and used during the processing of pork nuggets.

Pork and pork fat were tempered to 4°C by keeping in refrigerator overnight. Pork and pork fat were minced separately through a 4 mm plate in meat mincer. To the minced meat constituents, salt, sodium tripolyphosphate, sodium nitrite along with liquid whey and added water mixture were added in bowl chopper and chopped for one minute. Condiments and spice mix were added and chopped for another one minute and the emulsion thus prepared was formed in to pork nuggets using stainless steel box (16×11×2.5 cm) and cooked in pressure cooker for 20 min so that the product reaches an internal temperature of 73±1°C. After cooking the product were sliced in to cubes of 1-1.5 cm size. Representative samples of the cooked nuggets were served to panelists for sensory evaluation. Based on physico-chemical parameters (Emulsion pH, product pH, product yield and emulsion stability) and sensory evaluation, optimum level of the liquid whey in nuggets was selected. Using optimum level of inclusion, the nuggets were prepared and packed in polyethylene bags and stored under refrigeration (4±1°C) for 28 days for conducting storage studies. The samples were drawn on 0, 7, 14, 21 and 28 days for physico-chemical parameters (pH, Thiobarbituric acid reactive substances (TBARS) and Tyrosine Value (TV), microbial assessment (Total viable count, staphylococcal count, streptococcal count, coliform count, yeast and mould count) and sensory evaluation by panelists. pH of the pork nuggets was estimated using a digital pH meter. Emulsion stability was estimated as per the method outlined by Baliga and Madaiah (1971), as modified by Kondiah *et al*. (1985). Cooking yield was calculated as percentage of weight of pork nuggets after cooking to weight of the pork nuggets before cooking. Thiobarbituric acid reactive substances (TBARS) values of the nuggets was determined as per standard procedures (Tarladgis *et al*., 1960). Tyrosine value was also estimated as per standard outlined method (Strange *et al*., 1977). The samples were analysed for microbial analysis using standard procedures (APHA, 1984). Sensory characteristics of the pork nuggets was done using 9 point hedonic scale with the semi trained sensory panelists.

The data obtained on various parameters were subjected to statistical analysis (Snedecor and Cochran, 1994).

Results and Discussion

Analysis of variance revealed no significant ($p>0.05$) difference between treatments on the physico chemical characteristics except cooking yield (Table 1). The cooking yield of the nuggets was decreasing with the increasing replacement of water with liquid whey. Conversely a positive correlation with replacement of liquid whey in frankfurters was noticed (Yetim *et al*., 2001). Analysis of variance revealed that a significant ($p<0.01$) decrease of sensory characteristics for flavour, texture, juiciness and overall palatability with the increment in the replacement of water with liquid whey (Table 2). A slight decrease in the sensory scores such as flavour, texture and juiciness of the frankfurters with more than 25% replacement of added water by liquid whey was observed (Yetim *et al*., 2001). This may be due to the reduction in cooking yield with the increase in the replacement of added water. On the other hand no significant ($p>0.05$) difference was evident for appearance in pork nuggets with various levels of liquid whey. Based on the physico-chemical characteristics and sensory evaluation upto 20% of liquid whey can be used to replace added water to develop pork nuggets of acceptable quality and sensory characteristics.

Storage Stability of Pork Nuggets with 20% Liquid Whey Substitute for Added Water

The mean pH values of the pork nuggets increases with the increase of storage period during refrigerated storage, which is deemed to be significant ($p<0.01$) (Table 3). The increase of pH in the nuggets during storage might be due to the liberation of metabolites resulting from bacterial activity (Reddy and Rao, 1997).

The TBARS values of the pork nuggets significantly ($p<0.01$) increases with the increase in storage period. The increase in TBARS values throughout the storage period might be due to the oxidation of fatty acids (Reddy and Rao, 1997; Thompson *et al*., 1983). A linear increase of TBARS number was observed while studying the effect of calcium lactate on the quality and shelf life of restructured pork rolls at 4±1°C (Devatkal *et al*., 2003). A linear increase in TBARS values was

Table 1: Mean±SE values for physico-chemical parameters of pork nuggets with various levels of liquid whey as added water replacer

		Levels of liquid whey as added water replacer			
Particulars	No. of samples	20%	30%	40%	F-value
Emulsion pH	6	6.19±0.02^{a}	6.20±0.01^{a}	6.17±0.01^{a}	0.97^{NS}
Product pH	6	6.24±0.01^{a}	6.29±0.01^{a}	6.27±0.02^{a}	2.73^{NS}
Emulsion stability	6	88.61±1.67^{a}	84.28±3.08^{a}	82.18±3.03^{a}	1.54^{NS}
Cooking yield or Product yield	6	92.09±1.96^{a}	90.10±2.47^{b}	87.48±3.68^{b}	7.70**

Means bearing same superscripts between rows do not differ significantly, NS - Non Significant ($p>0.05$), **Highly significant ($p<0.01$)

Table 2: Mean±SE values for sensory characteristics of pork nuggets with various levels of liquid whey as added water replacer

		Levels of liquid whey as added water replacer			
Particulars	No. of samples	20%	30%	40%	F-value
Appearance	6	7.72±0.09^{a}	7.49±0.17^{a}	7.17±0.24^{a}	2.49^{NS}
Flavour	6	7.58±0.08^{a}	7.25±0.18^{ac}	6.66±0.23^{bc}	7.26**
Texture	6	7.62±0.06^{a}	7.23±0.12^{a}	6.57±0.17^{b}	17.08**
Juiciness	6	7.36±0.17^{a}	7.14±0.21^{a}	6.28±0.20^{b}	8.63**
Overall palatability	6	7.50±0.11^{a}	7.19±0.10^{a}	6.42±0.18^{b}	16.77**

Means bearing same superscripts between rows do not differ significantly, NS - Non Significant ($p>0.05$), **Highly significant ($p<0.01$)

Table 3: Mean±SE values for physico-chemical parameters of shelf life studies of pork nuggets with 20% liquid whey as added water replacer

Particulars	0th day	7th day	14th day	21st day	28th day	F-value
Emulsion stability (%)	91.17±2.14	-	-	-	-	-
Product yield (%)	93.34±1.07	-	-	-	-	-
Emulsion pH	6.13±0.03	-	-	-	-	-
pH	6.19±0.03^{a}	6.25±0.02^{ab}	6.33±0.02^{b}	6.44±0.03^{c}	6.60±0.05^{d}	52.71**
TBARs No. (mg of malonaldehyde/kg of sample)	0.09±0.01^{a}	0.15±0.03^{ab}	0.20±0.03^{b}	0.27±0.02^{c}	0.31±0.03	26.64**
Tyrosine value (mg/100 g of sample)	10.68±0.65^{a}	12.57±0.32^{b}	13.61±0.29^{bc}	14.65±0.20^{cd}	15.44±0.32^{d}	23.20**

n-6 samples, Means bearing same superscripts between rows do not differ significantly, **Highly significant ($p<0.01$)

noticed throughout the storage period while studying the quality characteristics of low fat ground pork patties containing milk co-precipitate (Kumar and Sharma, 2003). Even though, there was a linear increase in the TBARS values throughout the storage period, the values were very low which might be due to the presence of whey protein containing higher concentration of other components such as lactose which upon cooking could lead to the formation of antioxidative maillard components. These maillard reaction products could conceivably enhance the antioxidative potential of Whey Protein (Peria-Ramos and Xiong, 2001).

The mean values of tyrosine value of the pork nuggets increases during the shelf life study which is statistically deemed to be highly significant ($p<0.01$). The increase in tyrosine value during the storage period might be due to the denaturation of the protein in the nuggets (Naveena *et al*., 2001). They observed an increase in tyrosine value in smoked spent hen meat treated with ginger extract when stored at room temperature due to proteolysis.

The mean values for sensory characteristics of pork nuggets decreased throughout the storage period, which is deemed to be significant ($p<0.01$). Fat oxidation as indicated by increased TBA values in stored nuggets was the reason for getting lower colour and flavour scores (Table 4). Also the material used for packing was polyethylene which was a poor moisture barrier would have added to the above said cause. Loss of moisture during storage caused the pork nuggets to obtain lesser juiciness and texture scores (Reddy and Rao, 1997, 2000). They observed a similar reduction of appearance scores in chicken loaves and duck patties during refrigerated storage. It has been noticed that there was a reduction in overall palatability scores with increase in storage days (Reddy and Rao, 2000; Awonrin, 1993). They reported a reduction in overall palatability scores in chicken patties and chicken sausage upon storage at refrigerated temperature. The decrease in sensory scores could be attributed to surface drying and oxidative rancidity during storage. Flavour deterioration during storage might be due to microbial growth and oxidative rancidity (Devatkal *et al*., 2003).

Microbiological Characteristics

The mean values of the total viable counts gradually increased throughout the storage period, which is deemed to be significant ($p<0.01$). Reddy and Rao (1996) observed a similar increase of total plate counts while studying the effect of binders and precooking meat on quality of chicken loaves at refrigeration temperature. A significant ($p<0.01$) difference was evident for staphylococcal count during storage period (Xavier and Barquet, 1994). They reported a similar increase in mesophilic count in frankfurters during refrigerated storage. A significant ($p<0.01$) increase in yeast and mould count was also evident during the storage period of the pork nuggets. It was observed that there was sporadic occurrence of streptococcal and coliform counts during the storage period (Table 5). This might be due

Table 4: Mean±SE values for sensory characteristics of shelf life studies of pork nuggets with 20% liquid whey as added water replacer

Particulars	0th day	7th day	14th day	21st day	28th day	F-value
Appearance	7.68±0.10^{e}	6.99±0.16^{d}	6.56±0.08^{cd}	5.59±0.23^{b}	4.71±0.29^{a}	38.39**
Flavour	7.65±0.07^{e}	6.74±0.01^{d}	6.40±0.14^{c}	5.35±0.21^{b}	4.65±0.26^{a}	50.18**
Texture	7.63±0.11^{e}	6.86±0.12^{d}	6.48±0.08^{cd}	5.63±0.12^{b}	4.68±0.23^{a}	64.53**
Juiciness	7.66±0.05^{d}	6.54±0.12^{c}	6.27±0.16^{bc}	5.25±0.14^{b}	4.47±0.15^{a}	89.30**
Overall palatability	7.68±0.09^{e}	6.83±0.08^{d}	6.23±0.15^{c}	5.38±0.23^{b}	4.59±0.17^{a}	61.67**

n-6 samples, Means bearing same superscripts between rows do not differ significantly, **Highly significant ($p<0.01$)

Table 5: Mean±SE values for microbiological characteristics (log10 bacterial counts/g of sample) of shelf life studies of pork nuggets with 20% liquid whey as added water replacer

Particulars	0th day	7th day	14th day	21st day	28th day	F-value
Total viable count	3.19±0.07^{a}	3.47±0.15^{a}	4.19±0.12^{b}	4.99±0.25^{c}	6.00±0.20^{d}	45.23**
Staphylococcal count	2.77±0.12^{a}	3.05±0.21^{ab}	3.73±0.22^{bc}	4.23±0.33^{cd}	4.87±0.30^{d}	12.05**
Yeast and mould count	2.72±0.17^{a}	3.04±0.17^{ab}	3.57±0.28^{b}	4.38±0.26^{c}	4.83±0.19^{c}	16.36**

n-6 samples, Means bearing same superscripts between rows do not differ significantly, **Highly significant ($p<0.01$)

to the fact that good manufacturing practices during processing and consequent heat treatment upto 75°C (Gnanasambandam and Zayas, 1994). Further, pork nuggets with liquid whey upto 20% as a replacement to the added water were well acceptable upto 14 days by the panelists.

Conclusions

This study revealed that the liquid whey can be utilized to replace the added water upto 20% level without affecting the quality of pork nuggets. In addition the product can also be stored upto 14 days at refrigerated storage without affecting much of its shelf life qualities. By incorporating liquid whey in the comminuted meat products the most desirable quality pork nuggets can be developed with additional advantage of fortification, excluding the drying expenses to produce whey protein concentrates and elimination of environmental pollution due to draining of surplus liquid whey. Hence this formulation with liquid whey as water replacer is more beneficial for meat product industry as well as dairy industry.

Acknowledgment

The authors thank ICAR, New Delhi for the financial assistance offered under NAT Project on "Processing of Pork, Broiler and Eggs" and Tamil Nadu Veterinary and Animal Sciences University, Chennai for the facilities made available for this research project.

References

APHA., 1984. Compendium of Methods for the Microbiological Examination of Foods. 2nd Edn., M. L. Speck. American Public Health Association, Washington, DC.

Awonrin, S.G., 1993. Quality of smoked chicken + guinea fowl sausage as affected by processing conditions and cold storage. Lebensmittel-Wissenschaft-und-Technologie 24: 285-290.

Baliga, B.R. and N. Madaiah, 1971. Preparation of mutton sausages. J. Food Sci., 36: 607-610.

Devatkal, S., S.K. Mendiratta and A.S.R. Anjaneyulu, 2003. Effect of calcium lactate on the quality and shelf life of restructured pork rolls. J. Meat Sci., 1: 1-6.

Gnanasambandam, R. and J.F. Zayas, 1994. Chemical and bacteriological stability of frankfurters extended with wheat germ, corn germ and soy protein. J. Food Process. Pres., 18: 159-171.

Hung, S.C. and J.F. Zayas, 1992. Functionality of milk proteins and corn germ protein flour in comminuted meat products. J. Food Qual., 15: 139-152.

Kondaiah, N., A.S.R. Anjaneyulu, V. Kesavarao, N. Sharma and H.B. Joshi, 1985. Effect of salt and phosphate on the quality of buffalo and goat meats. Meat Sci., 15: 183-192.

Kosikowski, F.V., 1982. Cheese and Fermented Milk Products. Brooktondale, New York: Kosikowski and Asso., pp: 446.

Kumar, M. and B.D. Sharma, 2003. Quality characteristics of low fat ground pork patties containing milk co-precipitate. Asian Aust. J. Anim. Sci., 16: 588.

Lee, A., R.Y. Cannon and D.L. Huffman, 1980. Whey protein concentrates in a processed meat loaf. J. Food Sci., 45: 1278-1279.

Lyons, H.P., J. F. Kerry, P.A. Morisey and D.J. Buckley, 1999. The influence of added whey protein/ carragenangels and tapioca starch on the textural properties o f low fat sausages. Meat Sci., 51: 43-52.

Marriott, N.G., H. Wang, J.R. Clauss and P.P. Graham, 1998. Evaluation of restructed low fat ham containing whey. J. Muscle Foods, 9: 201-207.

McIntosh, G.H., P.J. Royle, R.K. Le Leu, G.O. Regester, M.A. Johnson, R.S. Grinsted, R.S. Kenward and G.W. Smithers, 1998. Whey proteins as functional ingredients. Intl. Dairy J., 8: 425-434.

Naveena, B.M., S.K. Mendiratta and A.S.R. Anjaneyulu, 2001. Quality of smoked hen meat treated with ginger extract. J. Food Sci. Technol., 38: 522-524.

Peria-Ramos, E.A. and Y.L. Xiong, 2001. Anti-oxidative activity of whey protein hydrolysates in a liposomal system. J. Dairy Sci., 84: 2577-2583.

Reddy, P.K. and T. Srinivasa Rao, 1996. Influence of binders and refrigerated storage on the quality characteristics of chicken patties. Indian J. Poult. Sci., 31: 110-114.

Reddy, P.K. and T.S. Rao, 1997. Influence of binders and refrigerated storage on certain quality characteristics of chicken and duck meat patties. J. Food Sci. Technol., 34: 446-449.

Reddy, P.K. and B.J. Rao, 2000. Effect of binders and precooking meat on quality of chicken loaves. J. Food Sci. Technol., 37: 551-553.

Serdaroglu, M. and M. Sapanci-Ozsumer, 2003. Effect of soy protein, whey powder and wheat gluten on quality characteristics of cooked beef sausages formulated with 5, 10 and 20% fat. Elect. J. Polish Agric. Univ., Series: Food Sci. Technol., 6: 68.

Serdaroglu, M. and E.E. Deniz, 2004. Chemical composition and quality characteristics and emulsion type turkey rolls formulated with dairy ingredients. J. Food Technol., 2: 109-113.

Snedecor, G.W. and W.M.Cochran, 1994. Statistical Methods. The Iowa State University Press. Iowa.

Strange, E.D., R.C. Benedict, J.L. Smith and C.E. Swift, 1977. Evaluation of rapid test for monitoring alteration in meat quality during storage I. Intact meat. J. Food Prot., 40: 843-847.

Tarladgis, B.G., B.M. Younathan and L.R. Dugan, 1960. A distillation method for the quantitative determination of malanoldehyde in muscle foods. J. Am. Oil Chem. Soc., 37: 403-406.

Thompson, L.D., A.S. Arafa and D.M. Janky, 1983. Stability of emulsions incorporating mechanically deboned poultry meat and soy flours. Poul. Sci., 62: 1367-1371.

Xavier C de, V.A. and N.J. Barquet, 1994. Shelf life of mechanically separated poultry meat stored under refrigeration. Coletanea-do-Insstituto-de-Technologia-de-Alimentos, 24: 91-104.

Yetim, H., W.D. Muler and M.Eber, 2001. Using fluid whey in comminuted meat products: Effects of technological, chemical and sensory properties of frankfurter type sausages. Food Res. Intl., 34: 97-101.