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Effect of Different Levels of Emulsion pH Adjusted with Lactic Acid on the Quality of Chicken Sausages

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ABSTRACT

The study was aimed at optimizing the pH hurdle during the process of development of shelf stable chicken sausages using hurdle technology. Different levels of emulsion pH (5.50, 5.70 and 5.90) adjusted with lactic acid were tried to develop acceptable quality of chicken sausages. It is observed that the sensory scores for appearance and flavour of the products made from emulsion with 5.70 were comparable to control. As the emulsion pH reduced, the sensory scores for juiciness, texture and overall palatability decreases significantly (P<0.05). Emulsion stability, cooking yield, moisture and fat content of chicken sausages decreased significantly (P<0.05) with decrease in emulsion pH level. Among the treatments emulsion stability and cooking did not differ significantly for emulsion pH 5.90 and 5.70.

Key words: Lactic acid, quality characteristics and chicken sausages

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I. INTRODUCTION

Poultry industry being an important wing of our Indian economy has been recognized as a potential tool to fight poverty and malnutrition with tremendous employment to about 1.5 million people along with indirect involvement of two million (RAMA RAO AND SHRAMA, 2007). The origin of poultry industry may be traced back to middle of the century where the birds were reared in the backyard to earn the supplementary income but during last three decades this enterprise has emerged in the form of an important organized sector. India ranks 5th in poultry meat production in the world producing 2.2 million tonnes of broiler meat which is quit low as compared to world meat production (ANONYMOUS, 2008). Consumption of poultry meat in India is increasing in recent years as large number of non-vegetarian population is switching over to poultry meat. Increased consumption of poultry meat is mostly because of rapid growth of poultry industry; relatively its cheaper cost, comparatively higher nutritional value and introduction of newer processed chicken products (BARBUT, 2001).

Meat is highly perishable, having short shelf life and high value commodity which requires special attention to prevent it from microbial spoilage. Meat is a rich source of high quality proteins and micronutrients which makes it susceptible to microbial spoilage as well as unfit for human consumption within 16-18 hrs under prevailing Indian climatic conditions. Extension of shelf life of fresh and semi-processed meat products has been a focus for many research groups. Refrigerated storage and transport of meat products are common in developed countries, whereas in many developing countries like India, these refrigerated facilities are limited, especially in rural areas, leading to reduced meat consumption. Hence alternate storage methods, which are cheaper, efficient and acceptable, have to be developed. Thus, there is an urgent need to improve the

Shelf stable meat products both traditional and novel are storable without refrigeration. These products are stable and safe due to a combination of factors (hurdles) which inhibit microbial growth; hence hurdle technology can be employed successfully in development of shelf stable chicken products. To maximize the effectiveness of these hurdles in foods, it is necessary to adopt a systems approach (hurdle technology) to meet the challenge posed by the need for food preservation and to avoid the limitations of refrigeration. Hurdle technologies in developed countries are mostly used to improve food safety, stability and quality. Hurdle technologies are proving to be more useful in developing countries like India (where electric interruption is one of the major problems) for the creation of novel foods which are stable at ambient temperature.

Acidulants are the substances added artificially and deliberately to lower the pH of food, thus extending storage life. Phosphoric acid is the only inorganic acid commonly used in food industry. However, a large number of organic acids such as citric, acetic and lactic acids are now being used as acidulants for a variety of food products. The organic acids in food, either present naturally of added artificially (weak acids), determined particular type of organisms survival or death, because of their effect on homeostasis and antimicrobial activity. Lowering of cytoplasmic pH is probably the major cause of inhibition of growth by weak acid food preservatives. In many foods, the cytoplasmic pH of microorganisms will normally be one or two units higher than that of their environment (Booth, 1995). If net proton influx cannot be prevented, cytoplasmic pH will fall, leading to cessation of growth and death of the cell (Troller, 1985).

Lactic acid is used as acidifies, pH control agent, curing and pickling agent as well as inhibitor of microbes (Burdock, 1997). The favorable properties of lactic acied that make it suitable for food applications are a) a mild acid taste in contrast to sharp of most other food acids, b) does not mask or overpower the weaker aromatic flavours of foods, c) has a distinct preservative action and regulates the microflora and d) occurs naturally in many foodstuffs, thus introducing no foreign element to the food. Lactic acid, which is Generally Recognized as Safe (GRAS) is used primarily as acidulant, flavouring and antimicrobial agent. The lactate content with pH of the tissue had a major role in favouring growth of some fermentative gram negative bacteria over that of others and thus alters the flora and it was more effective against anaerobic growth that aerobic growth at the ultimate pH (5.8) of the beef. Hence, the present study was planned to investigate effect of emulsion pH (adjusted with lactic acid) as one of hurdle on quality and shelf life of ready to eat shelf stable chicken sausages under ambient temperature.

II. MATERIALS AND METHODS

Chicken meat

Chicken meat required for the experiments were obtained from broilers of approx. 8 wks old slaughtered as per standard procedure at experimental abattoir of Livestock Products Technology Department, College of Veterinary & Animal Sciences, Parbhani. Meat was cut into cubes and ground using 10 mm plates in meat grinder (Stadler Pvt. Ltd., Mumbai). Ground meat was packed in LDPE pouches and stored in deep freezer at -18 ± 1^0 C till subsequent use. Frozen meat was thawed at 4 ± 1^0C (in refrigerator) for 16 hrs before use.

Spice mix

All the spice ingredients were cleaned to remove extraneous matter, dried in hot air oven at 60^{o}C for $2^1/_2$ hr and then ground in a grinder using proportionate quantity to obtain dry spices mix for preparation of chicken sausage. Spice mixture so obtained was stored in airtight plastic container and used subsequently as per the suggested formulation.

Table 1 Composition of spice mixture

Sr.No	Spice Ingredient	Quantity (% by weight)
1.	Aniseed (Soanf)	10
2.	Black pepper (Kali mirch)	07
3.	Capsicum (Mirch powder)	12
4.	Caraway seed (Ajowan)	10
5.	Cardamom (Badi elaichi)	05
6.	Cinnamon (Dalchini)	05
7.	Cloves (Laung)	02
8.	Coriander powder (Dhania)	14
9.	Cumin seeds (Zeera)	15
10	Dried ginger (Sunth)	15
11.	Turmeric (Haldi)	05
Total		**100**

Formulation of chicken sausages

A typical formulation as suggested by Biswas *et al*. (2007) with slight modification was used for preparation of chicken sausage throughout the study.

Table 2 Basic formulation of chicken sausage

Sr. No.	Ingredients	Quantity (% by weight)
1.	Meat	74.50
2.	Chicken fat	14.00
3.	Common salt	01.80
4.	Sodium tripolyphosphate	0.05
5.	Monosodium glutamate	0.50
6.	Spice mix	01.50
7.	Condiment paste	03.63
8.	Sugar	01.00
9.	Refined wheat flour	03.00
10.	Sodium nitrite	0.02
	Total	100

Chicken sausages preparation

Meat emulsion was prepared using Bowl chopper (Stadler Pvt. Ltd., Mumbai) as per the procedure mentioned hereunder. About 4 kg batches were prepared, namely, 2980 g deboned meat, 560 g chicken fat, 145.20 g condiments mix, 120 g refined wheat flour, 60 g spices mix, 72 g salt, 40 g cane sugar, 2 g sodium tripolyphosphate and 20 g monosodium glutamate. Also, sodium nitrite was added at 0.02 %. Spice mix was prepared as per the formulation developed in the laboratory (Table 1). Onion and garlic were used in the ratio 3:1 as condiments. Different ingredients were kept at 4 ± 1^0C for 1.5 hrs before chopping to reduce the temperature rise during emulsification. To the ground chicken meat, salt, sugar, sodium nitrite and sodium tripoly phosphate were added and chopped for about 2 min. Condiments mix was then added and chopped again for 2 min (water/ice flakes were not added to reduce the water activity in the sausages). Ground chicken fat was slowly incorporated while chopping which was continued till the fat was completely dispersed in the batter (3-4 min). Spice mix and refined wheat flour were added and chopping was continued for another 1 min to get a fine viscous emulsion. The temperature of the emulsion varied from 10-12^{0}C.

Experiment

About 4 kg meat emulsion was prepared as per the formulation mentioned above. The emulsion was divided in to 4 equal batches. First batch served as control (6.10) while the pH of the remaining 3 batches were 5.90, 5.70 and 5.50 using 0.5 N lactic acid solution, which was added slowly to the respective emulsions while chopping for 1 min in bowl chopper (Stadler Pvt. Ltd., Mumbai). The reason for selecting meat pH hurdle was that the sour products are least relished by Indians. Meat emulsions were then stuffed into 25 mm diameter artificial cellulose casings (Viskase Nojax, Viskase Co. Inc., Chicago, USA) using manual sausage filler (Stadler Pvt. Ltd., Mumbai) and linked manually at about 12 cm intervals. Cooking was done in a steam oven without pressure till the internal temperature reaches 75^0 C, as recorded by a digital probe thermometer. The sausages were cooled to room temperature and peeled off the casings.

Analytical Procedures

Physico-Chemical Characteristics

pH was determined by the method of Trout *et al*., (1992) using a digital pH meter (Model: LI 120, ELICO Pvt. Ltd., Hyderabad) equipped with a combined glass electrode. The weight of sausages was recorded before and after initial cooking and the yield was calculated (cooking yield= weight of cooked sausage/weight of raw sausages x 100) and expressed as percentage. The procedure of Baliga and Madaiah (1971) was to measure the emulsion stability. Moisture, fat and protein content of the sausages were determined as per standard procedures (AOAC, 1995).

Sensory Evaluation

Standard sensory evaluation method using 8-point descriptive scale (Keeton, 1983) was followed with modifications where 8= excellent, 1= extremely poor. The experienced panel (7 members) consisted of academic staff members and post-graduate students of Department of Livestock Products Technology, COVAS, Parbhani. Chicken sausages were warmed (40-45^0 C) using microwave oven for 1 min and served to the panelists. The panelists evaluated the samples for appearance, flavour, juiciness, texture and overall palatability using a standard score sheet. Sensory evaluations were conducted between 3.00- 3.30 pm and filtered tap water was provided to the panelists for rinsing their mouth in between evaluation of different samples.

Statistical Analysis

The experiment was replicated a minimum of three times and the data generated for different quality characteristics were compiled and analyzed using randomized block design. The data were subjected to analysis of variance (one way ANOVA), least significant difference (Snedecor and Cochran, 1989) and Duncan's multiple range tests (Steel and Torris, 1981) for comparing the means to find the effects between treatments for various parameters in different experiments. The smallest difference ($D_{5\%}$) for two means to be significantly different ($p<0.05$) is reported.

III. RESULTS AND DISCUSSION

Physico-Chemical Characteristics

The physicochemical properties of chicken sausages as influenced by different levels of emulsion pH adjusted with lactic acid are presented in Table 3

It is observed from table that the pH of the chicken sausages differ significantly ($P<0.05$) which were proportional to emulsion pH. Among the treatments, high pH was recorded for the product made with emulsion having pH 5.90 which did not differ significantly with the products having emulsion pH 5.70. Subsequent decrease of emulsion pH showed significant ($P<0.05$) decrease of product pH. Present findings are in agreement with that of Thomas *et al.,* (2008)[b].

Table 3 Effect of emulsion pH adjusted with lactic acid on physico-chemical characteristics of chicken sausage

Levels of emulsion pH	Quality Parameters					
	Product pH	Emulsion stability (%)	Cooking yield (%)	Moisture (%)	Protein (%)	Fat (%)
Control (6.10)	$6.27^{a} \pm 0.002$	$97.85^{a} \pm 0.10$	$96.60^{a} \pm 0.06$	$59.92^{a} \pm 0.08$	$19.12^{a} \pm 0.13$	$15.85^{a} \pm 0.07$
5.9	$6.02^{b} \pm 0.003$	$96.51^{b} \pm 0.12$	$95.32^{b} \pm 0.10$	$58.10^{b} \pm 0.06$	$20.53^{b} \pm 0.16$	$15.35^{b} \pm 0.06$
5.7	$5.95^{b} \pm 0.004$	$95.28^{b} \pm 0.14$	$94.27^{b} \pm 0.12$	$56.17^{c} \pm 0.03$	$21.57^{c} \pm 0.12$	$14.84^{c} \pm 0.10$
5.5	$5.60^{c} \pm 0.003$	$90.20^{c} \pm 0.13$	$91.16^{c} \pm 0.15$	$53.22^{d} \pm 0.05$	$22.63^{d} \pm 0.15$	$14.07^{d} \pm 0.12$

Means with common superscripts did not differ significantly ($P < 0.05$)
NS = Non significant

Emulsion stability (ES) and cooking yield (CY) decreased significantly ($P<0.05$) with decrease in pH level of emulsion. Among the treatments emulsion stability and cooking yield did not differ significantly for emulsion pH 5.90 and 5.70. Papadima and Bloukas (1999) stated that increase in denaturation occurred in muscle proteins at lower pH might be the reason for lower emulsion stability and cooking yield encountered in chicken sausages with lower pH values of emulsion. The present findings are in agreement with Barbut (2006) who reported that addition of liquid lactic acid caused pH drop, separation of moisture and fat which in turn resulted in lower cooking yield of salami type products.

Emulsion pH significantly ($P<0.05$) affected the moisture, protein and fat content of chicken sausages. The moisture content of chicken sausages decreased significantly ($P<0.05$) with decrease in emulsion pH level. A significant increase in protein content was observed with decrease in emulsion pH which might be attributed to the higher moisture and fat loss occured with decrease in emulsion pH. Hedric *et al.* (1994) and Person & Gillet (1996) reported that decline in pH of the product approaching the isoelectirc point of meat proteins reduce its water and fat binding capacities. On the contrary Pietrasik and Duda (2000) observed an inverse relationship between moisture and fat content which was attributed to the fat substitution by moisture in low fat products.

Sensory quality

Average scores for sensory attributes of chicken sausages as influenced by different levels of emulsion pH adjusted with lactic acid are presented in Table 4

Table reveals that emulsion pH was found to have significant ($P<0.05$) influence on juiciness, texture and overall palatability of the chicken sausages. Appearance and flavour of the products prepared from emulsion with pH 5.90 and 5.70 were comparable to control, while those of sausages made from emulsion with pH 5.50 were significantly ($P<0.05$) lower than that of control. Texture and overall palatability of the chicken sausages made from emulsion with pH 5.90 and 5.70 did not differ significantly but the difference is significant ($P<0.05$) than other treatments including control. The better juiciness and texture observed for sausages made from emulsion with higher pH 5.90 and 5.70 might be due to the better fat and water binding capacity in them as a result of lower denaturation of meat proteins. Sensory evaluation also indicated that the overall palatability scores for chicken sausages were mostly influenced by their juiciness and texture. Present findings are in

agreement with that of Karthikeyan *et al.,* (2000) who observed a linear reduction in flavour, juiciness and texture of goat meat keema with decrease in pH from 5.80 to 5.50.

Table 4 Effect of emulsion pH adjusted with lactic acid on sensory quality of chicken sausage

Levels of emulsion pH	Sensory attributes				
	Appearance	Flavour	Juiciness	Texture	Overall palatability
Control (6.10)	$7.07^{a} \pm 0.13$	$7.00^{a} \pm 0.06$	$7.05^{a} \pm 0.05$	$7.11^{a} \pm 0.12$	$7.22^{a} \pm 0.05$
5.9	$7.07^{a} \pm 0.11$	$7.00^{a} \pm 0.08$	$6.84^{b} \pm 0.01$	$6.93^{b} \pm 0.01$	$6.94^{b} \pm 0.07$
5.7	$7.07^{a} \pm 0.07$	$7.00^{a} \pm 0.10$	$6.78^{b} \pm 0.10$	$6.87^{b} \pm 0.04$	$6.83^{b} \pm 0.11$
5.5	$6.87^{b} \pm 0.10$	$6.67^{b} \pm 0.02$	$6.28^{c} \pm 0.07$	$6.50^{c} \pm 0.06$	$6.43^{c} \pm 0.13$

Means with common superscripts did not differ significantly ($P < 0.05$)
NS = Non significant

IV. CONCLUSIONS

Reduction of emulsion pH by adding lactic acid significantly decreased the processing and quality characteristics of chicken sausages. Emulsion pH of about 5.70 adjusted with lactic acid resulted in better quality characteristics in chicken sausages which were comparable to control. Reduction in emulsion pH below 5.70 affected different sensory attributes adversely. Moreover, panelists expressed a sort of sourness in products made from emulsion with pH 5.5.

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