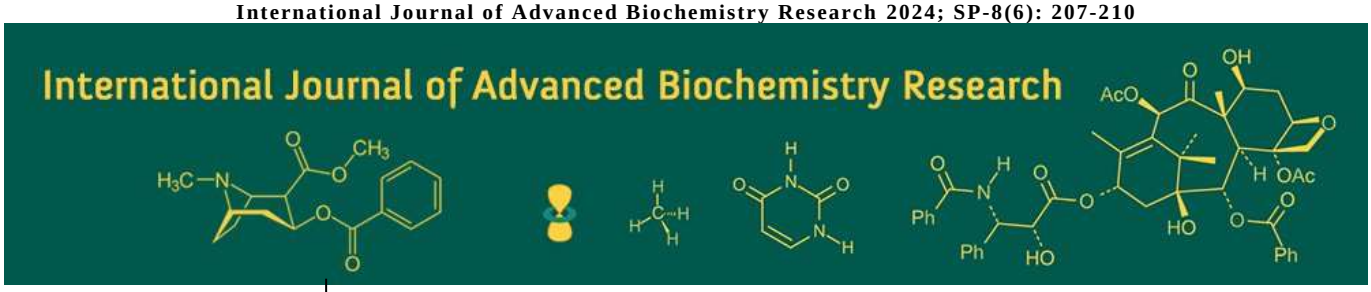

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Impact of lactic acid as acidulants on quality attributes of hurdle technology based chicken meat pickle

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Abstract
The present study was conducted at Department of Livestock Products Technology, College of Veterinary Sciences and Animal Husbandry, DUVASU, Mathura, Uttar Pradesh to develop and assess the quality characteristics of shelf stable chicken pickle incorporated with acidulant (lactic acid) as hurdle. Chicken pickle was prepared as per method, prescribed by Das *et al*. (2013) with slight modifications. Lactic acid was added as acidulant at 0.5, 1.0 and 1.5% level separately in chicken meat pickle. The pH, ash content, water activity and shear force values decreased whereas titrable acidity and moisture content increased significantly with incorporation of lactic acid. Among the sensory attributes, flavour, juiciness and overall acceptability of control and treatments with 0.5 and 1% level lactic acid had no significant difference; however, decreased significantly at 1.5% level. Therefore, it can be concluded that the best quality chicken pickle could be prepared with incorporation of 1% lactic acid in terms of physico-chemical, textural and sensory attributes.

Keywords: Meat pickle, acidulants, hurdle, lactic acid, shear force value

Introduction
India's poultry business has evolved from a mere backyard activity to a significant commercial agriculture-based enterprise, revolutionizing its structure and methods of operation. India's poultry industry is still seeing remarkable development despite a number of obstacles throughout the years. Over the past three decades, the poultry sector has grown at a pace of about 8% annually. The overall amount of meat produced in India in 2017-18 was 7.7 million tons, according to DAHD (2018). The percentages of meat produced by buffalo, cattle, sheep, goats, pigs, and poultry were 19.83%, 4.62%, 7.6%, 14.22%, 6.41%, and 47.32%, respectively. India comes in fifth place behind the US, Brazil, the EU, and China in terms of broiler meat output. According to the 19th Livestock Census, there are currently 729.21 million poultry in India. In 2016-17, India produced over 3.5 million tons of broiler meat (DAHD 2017). Since chicken meat is less expensive than mutton or chevon meat and is more extensively consumed in India than beef or hog, chicken meat is an important component of the country's non-vegetarian diet. Availability of high biological value animal protein, essential amino acids, fat, essential fatty acids, vitamins and other nutrients ensure its popularity among masses. Value addition and the use of appropriate technology might increase its acceptability and lead to higher demand and better financial returns.
Chicken meat pickle is a shelf stable intermediate moisture type product. A variety of components, including meat, spices, sauces, oil, vinegar, and other culinary additives, are included in this simple value-added product. While preparing pickles, cooking and frying denatures the proteins in the meat and reduces its ability to hold water, which causes the meat to reduce water and lengthen its shelf life. Cooking also eliminates microbes found in meat and enhances the flavour of meat pickles. Pickled chicken meat has a notable sensory quality with reduced levels of bacteria, yeast, and mold. But the qualities of the meat, formulation, the processing method, and the changes in temperature and cooking time all affect the keeping quality of chicken pickle. Any component or method that results in a higher moisture content or a higher pH might ruin the pickle by encouraging the growth of

microorganisms and oxidizing lipids.

The pH of the food also significantly impacts the lethality of heat treatment of the food. For meat products to stay stable during storage, a pH value of less than 5.0 is deemed necessary (Dziezak, 1986) [8]. The product's microbial load is decreased by higher acidity, salt content, heating, frying, and low moisture levels. Therefore, the goal of acidifying meat pickles is to stop germs from growing and stabilize their shelf life at room temperature. Depending on the kind and concentration of acid utilized, as well as the kinds of microbes contained in the food, acidified items may restrict microbial growth or survival. Since ancient times, food has been preserved by fermenting it and adding organic acids to make it more acidic. Organic acids are more effective preservatives in undissociated state. An organic acid acts as a preservative more effectively because the pH of the food is lowered. The impact of lactic acid on products is associated with changes in the acid/base balance, proton donation, and disruptions in the process of cellular energy generation. Due to its origin in fermentation during food manufacturing, lactic acid is also commonly thought of as a naturally occurring acid. It is added to meat products to help suppress the growth and survival of pathogens and to slow down the growth of rotting bacteria. These organic acids have different antibacterial effects depending on application technique, concentration, and temperature.

Materials and Methods

The experiments were conducted in the Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, DUVASU, Mathura. Live spent poultry birds were procured from Department of Poultry Science, DUVASU, Mathura. These birds were taken, given rest for 1-2 hours and then slaughtered at Meat Processing Laboratory following the standard procedure (Halal method). The lean carcass was eviscerated and dressed carcass was kept for conditioning in a refrigerator at 4±1°C for 4-6 hours and then frozen at -18°C till further processing. All other ingredients like salt, mustard oil, vinegar, spices of Agmark grade and condiments etc required for product preparation were procured from local market of Mathura. All the chemicals used in the study were procured from Hi Media Laboratories (P) Ltd, Mumbai, India. Thermo rigid air tight PET containers were sourced from local market for packaging and were pre-sterilized by exposing to U.V. light for 30 minutes before use.

Preparation of chicken pickle: The chicken pickle was prepared using Das *et al*. (2013) [7] method with slight modifications (Singh *et al*., 2019). Thawed chicken meat was cut into 1-2 inch chunks, and marinated with 1% salt and 1% turmeric powder for 30 minutes. The marinated chicken meat was then pre-cooked with appropriate cooking method for optimum time and then fried at 175±5 °C in pre-warmed mustard oil. In a separate kadahi containing prewarmed oil, mustards seeds, condiments, spice mix and salt were added consecutively followed by addition of fried meat chucks and vinegar and cooked for 5 minutes. The pickle was cooled to room temperature and packed in a pre-sterilized air tight PET container, with the remaining heated mustard oil filled to the top without leaving any air space. Chicken pickle was left for next 2 days at ambient temperature for maturing and then used for further analysis. The formulation used for preparation of chicken pickle is given in Table 1.

Analysis of product: Developed chicken pickle was evaluated for various physico-chemical properties as per standard procedures. The pH of chicken meat pickle was determined as per Trout *et al.* (1992) [18] method. Titrable acidity was determined as per Fisher and Peters (1968) [10]. Proximate composition such as moisture, fat, protein and ash percentage were evaluated as per AOAC (1995) [3]. Water activity of sample was measured by Aqua LAB dew point water activity meter 4TE. The colour parameters of the samples were measured using Hunter colorimeter of Color Tech PCM+ (Color Tec Associates Inc. Clinton NJ, USA). The coin shaped lance of instrument attached to software was directly put on the surface of chicken meat pickle at randomly chosen six different points (Hunter and Harold, 1987) [11]. Textural profile analysis, i.e. shear force value, was evaluated and measured with the help of instrumental texture profile analyzer (TA.HD Plus Texture Analyser) as per Bourne (1978) [6]. Sensory evaluation was carried out using eight-point hedonic scale with 8 = extremely desirable and 1 = extremely poor (Keeton, 1983) [13]. A sensory panel (semi-trained) of seven judges drawn from post-graduate students and faculty of Veterinary College, DUVASU, Mathura, India, were requested to evaluate the product for different quality attributes *viz*., colour and appearance, texture, flavour, texture, juiciness, saltiness, sourness and overall acceptability in sensory room of department. Plain lukewarm water was given for mouth rinsing in between sensing two samples. The freshly prepared chicken meat pickles after ageing were given for sensory evaluation at normal room temperature in late afternoon around 4:00 p.m. A total of three replications were carried out, with each analysis done in duplicate (n = 6), except sensory studies where seven sensory panelists did sensory evaluation three times and n = 21 observations were recorded for each sensory attribute.

Statistical analysis

The data generated from various trials under each experiment were pooled and analyzed by statistical method of one way-ANOVA and mean ± S.E. using SPSS-16.0 software package and sub-class of means were compared by using Dunkan's multiple range test at 5% level (Dunkan, 1955) [9].

Results and Discussion

Physico-chemical properties

The effects of lactic acid on physico-chemical properties of chicken meat pickle are presented in table 2. The pH values decreased significantly ($p<0.05$) while titrable acidity increased significantly ($p<0.05$) with increased level of lactic acid in treatments due to acidic nature of lactic acid. Sharma *et al*. (2016) [14] also observed lower pH and higher titrable acidity of chicken croquettes incorporated with lactic acid at different concentrations than control. Moisture content increased significantly ($p<0.05$) while ash content and a_w values decreased significantly ($p<0.05$) in treatments than control. Aktas *et al*. (2003) [1] also reported that meat marinated in lactic acid solution had significantly ($p<0.05$) higher moisture content than control due to moisture retention capacity of lactic acid. Barbut (2006) [4] reported that addition of liquid lactic acid caused immediate pH drop and separation of moisture and fat, which in turn resulted in lower cooking yield of salami type products. There was no significant difference observed in protein and ash content between control and treatments.

Colour and textural parameters

There was no significant difference in lightness (*L**), redness (*a**) and yellowness (*b**) values between control and treatments, however *a** values increased and *L** and *b** values decreased slightly with increased level of lactic acid. Bloukas *et al*. (1997) [5] and Andres *et al*. (2006) [2] also reported no significant change in colour values of vacuum packaged low fat frankfurters and low-fat chicken sausages respectively with addition of 2% lactic acid. Shear force values decreased significantly ($p<0.05$) in LA2 and LA3 than control. Thomas *et al*. (2010) [17] also observed that shear force and work of shearing decreased significantly ($p<0.01$) in pork sausages with incorporation of lactic acid due to protein denaturation and subsequent loss in binding properties of meat proteins. Sheard and Tali (2004) [15] also reported that decrease in pH below or above of isoelectric point of myofibrillar protein decreased the hardness of meat products.

Sensory evaluation

Colour and appearance score of control were significantly ($p<0.050$ higher than treatments due to protein denaturation and partial charring of product; however, there was no significant difference among the treatments. There was no significant difference in saltiness and texture scores between control and treatments. Sourness scores of LA1 and LA2 were significantly ($p<0.05$) higher than control and LA3, as incorporation of lactic acid provided sourness and tangy flavour to chicken pickle, which was much liked by sensory panellists. However sensory panellists reported unpleasant sourness and flavour in product at higher level (1.5%) of acid in LA3. Flavour, juiciness and overall acceptability score of control, LA1 and LA2 had no significant difference but decreased significantly ($p<0.05$) in LA3. Juncher *et al*. (2000) [12] also observed that no significant change in sensory scores of cooked cured emulsion type meat products with addition of 2% lactic acid + 0.25% Glucono Delta-Lactone, however decreased significantly ($p<0.05$) at higher level of lactic acid.

Table 1: Formulation used for preparation of chicken meat pickle

S.N.	Ingredients	Weight(gm)
1	Chicken meat	1000 gm
2	Mustard oil	500 gm
3	Salt	30 gm
4	Dry Spice mix	30 gm
5	Condiments	80 gm
6	Vinegar	100 ml
7	Turmeric powder	10 gm
	Total	100

Table 2: Effect of lactic acid on physico-chemical properties (Mean±SE) of chicken meat pickle

Parameters	C	LA1	LA2	LA3	Treatment Mean
pH	5.41^{a}±0.02	5.09^{b}±0.05	4.89^{c}±0.02	4.31^{d}±0.02	4.92±0.06
Titrable acidity	0.78^{c}±0.02	0.85^{b}±0.05	0.91^{ab}±0.02	1.01^{a}±0.01	0.88±0.02
Moisture (%)	43.75^{c}±0.07	46.29^{b}±0.05	47.49^{b}±0.04	48.01^{a}±0.14	46.38±0.09
Protein (%)	18.37 ±0.04	18.47 ±0.02	18.54 ±0.03	18.50 ±0.06	18.47±0.10
Fat (%)	28.23±0.25	27.41±0.33	26.70±0.24	26.41±0.12	27.19±0.18
Ash (%)	6.98^{a}±0.04	6.34^{ab}±0.06	5.83^{b}±0.03	5.58^{b}±0.04	6.18±0.11
Water activity (a_w)	0.949^{a}±0.07	0.934^{b}±0.04	0.929^{b}±0.09	0.923^{c}±0.03	0.933±0.06

C- steam cooking (without pressure) of marinated chicken meat for 15 minutes (control)
LA1- chicken meat pickle incorporated with 0.5% lactic acid
LA2- chicken meat pickle incorporated with 1.0% lactic acid
LA3- chicken meat pickle incorporated with 1.5% lactic acid
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($p<0.05$)

Table 3: Effect of lactic acid on colour and textural parameters (Mean±SE) of chicken meat pickle

Parameters	C	LA1	LA2	LA3	Treatment Mean
Lightness (*L**)	30.63±0.73	29.93±0.85	28.59±0.61	27.31±0.57	29.11±0.77
Redness (*a**)	4.78±0.83	5.21±0.53	5.91±0.88	6.56 ±0.80	5.61±0.66
Yellowness (*b**)	5.19±0.70	5.14±0.61	4.75 ±0.91	4.49 ±0.92	4.89±0.43
Shear force (N/cm^2)	63.05^{a}±0.34	56.76^{ab}±0.55	53.27^{b}±0.40	51.06^{c}±0.37	56.03±0.58

C- steam cooking (without pressure) of marinated chicken meat for 15 minutes (control)
LA1- chicken meat pickle incorporated with 0.5% lactic acid
LA2- chicken meat pickle incorporated with 1.0% lactic acid
LA3- chicken meat pickle incorporated with 1.5% lactic acid
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($p<0.05$)

Table 4: Effect of lactic acid on sensory attributes (Mean±SE) of chicken meat pickle

Attributes	C	LA1	LA2	LA3	Treatment Mean
Colour and appearance	7.32^{a}±0.02	7.22^{b}±0.01	7.20^{b}±0.01	7.18^{b}±0.01	7.23±0.01
Flavour	7.33^{a}±0.01	7.35^{a}±0.01	7.39^{a}±0.01	7.16^{b}±0.01	7.23±0.01
Texture	7.46 ±0.09	7.44 ±0.11	7.46±0.21	7.34 ±0.31	7.42±0.14
Juiciness	7.41^{a}±0.04	7.40^{a}±0.06	7.42^{a}±0.02	7.18^{b}±0.06	7.35±0.04
Saltiness	7.28±0.08	7.24±0.03	7.19±0.05	7.21±0.06	7.23±0.04
Sourness	7.27^{b}±0.01	7.32^{a}±0.01	7.33^{a}±0.01	7.09^{c}±0.02	7.25±0.01
Overall acceptability	7.48^{a}±0.03	7.38^{a}±0.01	7.44^{a}±0.02	7.11^{b}±0.02	7.35±0.01

C- steam cooking (without pressure) of marinated chicken meat for 15 minutes (control)
LA1- chicken meat pickle incorporated with 0.5% lactic acid
LA2- chicken meat pickle incorporated with 1.0% lactic acid
LA3- chicken meat pickle incorporated with 1.5% lactic acid
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($p<0.05$)

Conclusion

Incorporation of lactic acid as acidulants in chicken meat pickle resulted into significant effect on various physico-chemical, colour, textural and sensory properties. The pH, ash content, water activity and shear force values decreased significantly whereas titrable acidity and moisture content increased significantly ($p<0.050$ with increased level of lactic acid in chicken pickle. The lightness (L^*), redness (a^*), and yellowness (b^*) values did not significantly differ between the treatments and the control. Among the sensory attributes, sourness scores of treatments with 0.5 and 1% lactic acid were significantly higher than control. Flavour, juiciness and overall acceptability of control, treatments with 0.5 and 1% lactic had no significant difference; However, decreased significantly in treatments with 1.5% lactic acid. Therefore, LA2- chicken pickle incorporated with 1.0% lactic acid was selected as the best treatment.

Authors' contributions

SS conducted all the experiments and wrote manuscript; MG and SS designed the study; SS, MG Vivekanand edited the manuscript; Vivekanand helped with data tabulation and statistical analysis, VP and MG supervised the work;

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