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Effect of pre-cooking of marinated chicken meat on physico-chemical properties and sensory attributes of shelf stable chicken pickle

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Abstract

This study was carried out to evaluate the effect of precooking of marinated chicken meat by different methods on Physico-chemical properties and sensory attributes of chicken pickle. Chicken pickle was prepared by method prescribed by Das *et al.* (2013) with slight modifications. Several preliminary trials were conducted for pre-cooking of marinated chicken meat using three different methods at different time-temperature combinations- steam cooking (without pressure), frying and microwave cooking and evaluated for various physico-chemical and sensory properties. Three processing conditions, one from each precooking method of marinated chicken meat - steam cooking (without pressure) for 15 minutes (S); frying for 15 minutes (F) and microwave cooking at 540 MHz for 10 minutes (M) were found optimum. These three optimized methods were further compared to select the best quality chicken pickle. There was a significant difference ($P < 0.05$) among the treatments for all physico-chemical properties, except ash content and water activity. S had significantly ($P < 0.05$) higher pH and lower titrable acidity than F and M. The moisture content of F was significantly ($P < 0.05$) lower whereas protein and fat content of F significantly ($P < 0.05$) higher than M and S. *lightness* (L^*), redness (a^*) and shear force values were significantly ($P < 0.05$) different with different precooking methods. The sensory scores including overall acceptability were significantly ($P < 0.05$) higher in steam cooked chicken meat pickle. Therefore, precooking of marinated chicken meat by steam cooking (without pressure) for 15 minutes for preparation of chicken pickle was found the best method.

Keywords: Chicken pickle, quality characteristics, steam cooking without pressure, frying, microwave cooking

Introduction

Traditional food enriches our sensory perception by providing wide variety of flavour, colour and texture. Pickle is well known for its appetite enhancing property and help in digestion of food by stimulating the flow of gastric juices. Meat pickles are traditional unfermented, spicy ready to eat delicious and nutritious meat preparation generally stable for several weeks due to low moisture content (Maiti *et al.*, 2009) [11]. Pickling helps to utilize tough low quality meat and process it into shelf stable convenience product. Chicken meat is most widely accepted meat in India unlike beef or pork and the price of chicken meat is lower than that of mutton or goat meat hence chicken meat makes an important component in Indian non-vegetarian diet. Poultry sector in India has undergone a paradigm shift in structure and operation from a mere backyard activity into a major commercial agriculture based industry. Poultry industry has been rising at the rate of around 8 percent per annum over the past three decades. As per DAHD (2018), total meat production in India was 7.7 million tonnes in 2017-18 out of which poultry meat contribute around 47.32%. India ranks fifth in broiler meat production after US, Brazil, European Union, China producing 4.5 million tonnes in 2017-18 (DAHD, 2018). Presently more emphasis is given on ready to eat shelf stable meat products with change in life style, increased per capita income, urbanization, consumer awareness and increasing number of women entering in job. Chicken meat pickle is a shelf stable intermediate moisture type product. It is value added convenient product containing various ingredients like meat, spices, condiments, oil, vinegar and other food additives. Marinating is a traditional culinary technique that is used to tenderize and to improve flavour and juiciness of poultry meats. Sodium chloride, spices and sugars are considered important ingredients of marinades, as they improve meat tenderness and flavour. Marinating also increases water binding capacity of meats, thus reducing cooking losses and improving meat juiciness (Froning and Sackett,

1985). Cooking has been considered as a very critical step in the preparation of meat products affecting nutritive value, organoleptic properties thus consumer acceptance. Cooking and frying during pickle making denatures meat proteins and decreases water holding capacity of meat resulting in loss of water and increase its shelf life. Cooking also improves palatability of meat pickle and causes destruction of microorganisms present in meat. However quality characteristics of chicken pickle are also dependent on characteristics of meat, formulation and processing technique as well as time/temperature evolution during cooking. Meat undergoes many changes during cooking, both physical and chemical, including weight loss, modifications of water holding capacity, texture, muscle fiber shrinkage, color and aroma development (Walsh *et al.*, 2010) [20]. In particular, it is widely recognized that meat tenderness is the most significant factor affecting consumers' satisfaction (Obuz, *et al.*, 2003) [14]. The improvement of tenderness in meats is mainly caused by changes in the structure of connective tissues solubilized by heat, while at the same time heat-denaturation of myofibrillar proteins generally causes meats toughening (Palka and Daun, 1999) [15]. As a consequence, the key eating quality characteristics of meats (for example, cooking loss, tenderness and crust formation), are mainly affected by both the cooking technique and by the time-temperature profiles (Murphy and Marks, 2000) [12]. The measurement of changes occurring during meat cooking may be carried out by a wide range of analytical methods, including textural, colour and microstructural evaluations (Yoon, 2002) [21]. Therefore, the present study was aimed to evaluate the effect of precooking of marinated chicken meat by different methods on quality characteristics of chicken pickle.

Materials and Methods

The experiments were conducted in the Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, DUVASU, Mathura. The water activity (aw), colour and textural parameters were conducted at Central Institute for Research on Goats (CIRG), Makhdoom, Mathura. Live poultry birds were procured from Department of Poultry Science, DUVASU, Mathura. These birds were taken and humanely slaughtered at Meat Processing Laboratory at Department of Livestock Products Technology, College of Veterinary Sciences and Animal Husbandry, DUVASU, Mathura. 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 Spice Mix

The ingredients in desired ratio were procured from local market, dried at 45±2 °C for 2 hours followed by grinding in food grinder (Inalsa Mixie) and sieving through mesh. The spice mix was stored in pre sterilized low density polyethylene bags and used as per requirement. The composition of spice mix is given in Table 1.

Table 1: Composition of Spice Mix

Serial No.	Ingredients	Percentage (%)
1.	Coriander powder (Dhaniya)	15
2.	Cumin seed (Jeera)	15
3.	Caraway seed (Ajwain)	10
4.	Fennel seeds (Soanf)	10
5.	Black pepper (Kalimirch)	10
6.	Red chilli powder	08
7.	Dried Ginger powder (Soath)	08
8.	Cinnamon (Dalchini)	05
9.	Clove (Loang)	05
10.	Black cardamom (Badi elaichi)	05
11.	Mace (Javitri)	05
12.	Nutmeg (Jaifal)	02
13.	Green cardamom (Choti elaichi)	02
	Total	100 %

Preparation of chicken pickle

The chicken pickle was prepared as per method followed by Das *et al.* (2013) [3] with slight modifications (Singh *et al.*, 2017). Frozen dressed meat was thawed at refrigeration temperature overnight and thawed meat was cut into smaller chunks of 1-2 inch. All the ingredients *i.e.* common salt, mustard oil, vinegar, turmeric powder, condiments and spice mix were weighed accurately as per the formulation. Meat chunks were mixed with 1% salt and 1% turmeric powder and kept for 30 minutes for marination. The marinated chicken meat was then pre-cooked with appropriate cooking method for optimum time. Pre-cooked meat chunks were then fried at 175±5 °C in pre warmed mustard oil to get golden brown colour. Condiments were prepared and fried in separate kadahi in preheated mustard oil along with mustard seeds and then spice mix and salt were added to it. Finally precooked-fried meat chunks and vinegar were added to it and cooked for 5 minutes. Thus, prepared chicken meat pickle was cooled down to room temperature and then packed in pre sterilized air tight PET container, where remaining heated mustard oil was filled in container till it's 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 2.

Table 2: Formulation used for preparation of chicken 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

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) method. Titrable acidity was determined as per Fisher and Peters (1968). Proximate composition such as moisture, fat, protein and ash percentage was evaluated as per AOAC (1995) [1]. Water activity of sample was measured by Aqua LAB dew point water activity meter 4TE. The color parameters of the samples were measured using Hunter colorimeter of ColorTech 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) [7]. 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) [2]. Sensory evaluation was carried out using eight-point hedonic scale with 8 = extremely desirable and 1 = extremely poor (Keeton, 1983) [8]. 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., color and appearance, texture, flavor, 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 developed as per the procedure of Snedecor and Cochran (1995) [18], and means were compared by using Duncan's multiple range test at 5% level (Duncan, 1995) [5].

Results and Discussion

Precooking of marinated chicken meat with different cooking methods

Several preliminary trials were conducted for pre-cooking of marinated chicken meat using three different methods at different time-temperature combinations- steam cooking (without pressure) at 121 °C for 10, 15 and 20 minutes, frying at 175 °C for 10, 15 and 20 minutes and microwave cooking at 540 MHz for 10, 15 and 20 minutes; and evaluated for various physico-chemical and sensory properties. Three processing conditions, one from each pre cooking method of marinated chicken meat - steam cooking (without pressure) for 15 minutes (S); frying for 15 minutes (F) and microwave cooking at 540 MHz for 10 minutes (M) were found optimum. These three optimized methods (S, F, M) were further compared in next sub experiment to select the best pre cooking method of marinated chicken meat for preparation of chicken pickle.

Comparison of optimized pre-cooking methods on quality characteristics of chicken pickle

Physico-chemical properties

The effects of different pre cooking methods of marinated chicken meat on physico-chemical properties of chicken meat pickle are presented in Table 3. pH of S was significantly ($P<0.05$) higher while titrable acidity was significantly ($P<0.05$) lower than F and M; however, there was no significant difference between F and M. Choi *et al.* (2016) also observed significantly ($P<0.05$) higher pH of marinade chicken steak prepared by steam cooking than microwave cooking. Moisture content of S and M was significantly ($P<0.05$) higher than F2, whereas protein and fat content of F was significantly ($P<0.05$) higher in F than S and M. These

findings might be due to more fat retention and moisture loss in frying of marinated chicken meat than other two pre cooking methods. Devi and Sarojnalini (2012) [4] also observed significantly ($P<0.05$) lower moisture and higher fat content in deep fried fish than steamed and curried fish due to oil absorption in fish meat along with partial moisture evaporation. Nisar *et al.* (2010) [13] also observed significantly ($P<0.05$) higher moisture content in buffalo patties prepared by steam cooking than microwave and hot air cooking. There was no significant difference in ash content and aw values among the treatments.

Table 3: Effect of different precooking methods on physico-chemical properties (Mean±SD) of chicken pickle

Parameters	S	F	M	Treatment Mean
pH	5.32 ^a ±0.11	5.14 ^b ±0.03	5.13 ^b ±0.06	5.19±0.12
Titrable acidity	0.77 ^b ±0.02	0.81 ^a ±0.01	0.80 ^a ±0.05	0.79±0.03
Moisture (%)	44.38 ^a ±0.02	40.27 ^b ±0.02	44.21 ^a ±0.04	42.95 ±0.42
Protein (%)	18.99 ^b ±0.03	19.59 ^a ±0.02	19.04 ^b ±0.12	19.20±0.10
Fat (%)	28.19 ^b ±0.04	30.22 ^a ±0.04	28.20 ^b ±0.04	28.87±0.23
Ash (%)	6.44±0.26	6.53±0.55	6.36±0.33	6.44±0.22
Water activity (a _w)	0.941±0.01	0.946±0.01	0.940±0.01	0.942±0.01

Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($P<0.05$), N= 6, S= steam cooking (without pressure) of marinated meat at 121 °C for 15 minutes, F=frying of marinated meat at 175 °C for 15 minutes and M= microwave cooking of marinated meat at 540 MHz for 10 minutes

Instrumental colour and textural parameters

The effects of different pre cooking methods of marinated chicken meat on colour and textural parameters of chicken meat pickle are presented in Table 4. Lightness (L^*) values of F were significantly ($P<0.05$) lower while redness (a^*) values significantly ($P<0.05$) higher than S and M due to enzymatic browning and frying of meat which gave dark brown colour to product. There was no significant difference in yellowness (b^*) values among the treatments. Khanam (2017) [9] and Parang *et al.* (2011) [16] also observed no significant ($P<0.05$) difference in yellowness (b^*) values of chicken meat spread and *Longissimus dorsi* muscle of veal meat respectively cooked by various cooking methods. Shear force values of M1 were significantly ($P<0.05$) higher than S and F; however there was no significant difference between S and F.

Table 4: Effect of different precooking methods on colour and textural parameters (Mean±SD) of chicken pickle

Parameters	S	F	M	Treatment Mean
Lightness (L^*)	29.96 ^a ±0.79	28.62 ^b ±0.63	30.13 ^a ±0.81	29.57±0.48
Redness (a^*)	4.28 ^b ±0.90	5.89 ^a ±0.69	4.83 ^b ±0.59	5.00±0.60
Yellowness (b^*)	5.17±0.70	5.01±0.63	5.63±0.88	5.27±0.55
Shear force (N/cm ²)	63.55 ^b ±0.27	64.72 ^b ±0.57	67.18 ^a ±0.88	65.15±1.81

Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($P<0.05$), N= 6, S= steam cooking (without pressure) of marinated meat at 121 °C for 15 minutes, F=frying of marinated meat at 175 °C for 15 minutes and M= microwave cooking of marinated meat at 540 MHz for 10 minutes

Sensory evaluation

The effects of different pre-cooking methods of marinated chicken meat on sensory attributes of chicken meat pickle are presented in Table 5. Colour and appearance as well as texture scores of S and M were significantly ($P<0.05$) higher than F due to dark brown color and comparatively less palpability of product in F due to frying for 15 minutes. There was no significant ($P<0.05$) difference in saltiness and sourness among the treatments as same amount of salt and

acid were added in the formulation. Flavour, juiciness and overall acceptability scores of S were significantly ($P<0.05$) higher than M and F due to tenderness, higher moisture content, pleasant flavour and aroma of product. Kim *et al.* (2018) [10] also reported that pre-cooking with superheated steam was the best method than grilling, pan frying and infrared cooking for reheating of frozen marinated pork loin. Therefore, S- pre-cooking of marinated chicken meat by steam cooking (without pressure) for 15 minutes for preparation of chicken pickle was selected as the best method.

Table 5: Effect of different pre-cooking methods on sensory attributes (Mean±SE) of chicken pickle

Attributes	S	F	M	Treatment Mean
Colour and appearance	7.33 ^a ±0.10	7.26 ^b ±0.05	7.32 ^a ±0.05	7.30±0.07
Flavour	7.45 ^a ±0.07	7.30 ^b ±0.04	7.38 ^b ±0.05	7.37±0.08
Texture	7.47 ^a ±0.06	7.25 ^b ±0.04	7.42 ^a ±0.06	7.38±0.11
Juiciness	7.44 ^a ±0.04	7.20 ^c ±0.07	7.35 ^b ±0.04	7.33±0.05
Saltiness	7.19±0.06	7.15±0.07	7.20±0.06	7.18±0.10
Sourness	7.21±0.07	7.16±0.09	7.19±0.05	7.18±0.09
Overall acceptability	7.49 ^a ±0.01	7.29 ^c ±0.01	7.39 ^b ±0.03	7.39±0.02

Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($P<0.05$), N= 21, S= steam cooking (without pressure) of marinated meat at 121°C for 15 minutes, F=frying of marinated meat at 175°C for 15 minutes and M= microwave cooking of marinated meat at 540 MHz for 10 minutes

Conclusion

The pre-cooking of marinated chicken meat with different methods had significant effect on various physico-chemical, colour, textural and sensory properties. Among the pre cooking methods, steam cooking (without pressure) improved the quality characteristics of final product in terms of juiciness, tenderness and flavour with no adverse effect on texture, colour and sensory properties of product. Therefore, steam cooking (without pressure) of marinated chicken meat for 15 minutes was selected as the best pre-cooking method to improve the quality characteristics of chicken pickle.

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