



Original Research

Development of Shelf Stable Spent Hen Meat Kachori Incorporated With Prebiotic Fibers

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Abstract

The formulation and processing condition for the development of vegetable kachori were standardized. The effect of different cooking methods i.e. (baking, baking + frying combination and deep fat frying) on developed kachori was evaluated and on the basis of sensory attributes, deep fat frying cooking method was found most suitable. Minced chicken meat was incorporated at 55%, 65% and 75% level in the developed kachori and on the basis of various physico-chemical, sensory quality and instrumental color parameters, 75% level was adjudged best for the development of chicken meat kachori. Inulin powder was incorporated at 2%, 4% and 6% levels in the standardized formulation of chicken meat kachori for the development of prebiotic enriched functional chicken meat kachori and 4% level was found optimum on the basis of various physico-chemical, sensory quality and proximate composition parameters.

Key words: Inulin, Frying, Meat Kachori, Shelf Stable, Sensory

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Introduction

India has emerged on the world poultry map as the third largest egg producer with 88.1 billion eggs in the year 2017-18 (BAHS, 2018). As a result of this large number of spent hen are produced every year, so there is a very large proportion of spent layer/hen meat available, which has poor acceptability and fetches lower price in the market due to innate toughness of meat. As scope of income generation and profit margin is limited with layer farming, due to the seasonal fluctuation in demand and price of eggs, it is very essential to utilize spent hen meat into value added meat products. It will open up new opportunities for the marketing as well as will increase the profit margin of the layer farmers. Demand for the ready to eat, ready to prepare



and shelf stable foods with added functionality is increasing with change in lifestyle, food habits and increase in the number of double-income families in developing world (Mishra *et al.*, 2017). Snack foods are better option to fulfill these demands, snack foods are defined as ready-to-eat or prepare (RTE/RTP) convenient food products, generally eaten in between regular meals as small meal for purpose of satisfying hunger as well as supplying energy and nutrient. Such foods are less perishable, more durable, more appealing and shelf-stable in nature.

Kachori is a popular snack product in Rajasthan, Uttar Pradesh, Madhya Pradesh and other parts of Northern India. It is usually a round flattened ball made of fine flour filled with a stuffing of baked mixture of pulses, besan, black pepper, red chili powder, salt and other spices and condiments, which are deficient in essential amino acids, B-complex vitamins, minerals (zinc and iron) and essential fatty acids, but all these important dietary components can be easily available from animal sources (Biesalski, 2005). Meat and meat products are important sources of protein, fat, essential amino acids, minerals and vitamin and other nutrients (Biesalski, 2005). With the increasing awareness and growing interest in the animal protein, the growth of such meat incorporated snack is increasing day by day. The demand for meat products with incorporated functional ingredients has sharp rise in recent years (Zhang *et al.*, 2010). The consumer acceptance of functional foods varies widely depending upon their social, economic, geographical, political, cultural and ethnic backgrounds (Jimenez-Colmenero *et al.*, 2001). Prebiotics are defined as non-digestible food ingredients that beneficially affect the host by stimulating the growth and/or activity of beneficial bacteria (probiotics) in the colon. The health benefits of prebiotics include increased mineral absorption (Rastall, 2010), improved immune response (Seifert and Watzl, 2008) and colorectal cancer prevention (Asad *et al.*, 2008) or cancer therapy (Taper and Roberfroid, 2008).

The fructo-oligosaccharides such as inulin are now considered as the model prebiotics (Roberfroid, 2008). Inulin has been tested in variety of meat products such as sausage and mortadella (Garcia *et al.*, 2006). Inulin is a natural food ingredient commonly found in varying percentages in dietary foods (Niness, 1999). It is a heterogeneous blend of fructose polymers found commonly in nature as plant storage sugars. These prebiotic fibers display excellent fat-substitution properties in meat products. Therefore, the addition of inulin as a source of dietary fiber and to exert prebiotic effect (Weiss *et al.*, 2010) may be of greater interest for the development of functional chicken meat kachori. Products that can be stored at ambient temperature for longer time without the risk of microbial spoilage are considered to be shelf stable. Shelf stable meat products are important in developing countries like India where the maintenance of cold chain for the transportation and storage of meat and other perishable food products is very difficult (Kumar *et al.*, 2015). Therefore, development of shelf-stable functional chicken meat kachori was an innovative approach to provide a product which will provide all the appropriate nutrients in a convenient form to the consumers.

Materials and Methods

Source of Raw Materials

Spent Hen Meat

The White Leghorn spent hens (>72 weeks) were procured from poultry farm of Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana and were slaughtered as per standard procedure, with the consideration of animal welfare aspect, in the experimental slaughterhouse of Department of Livestock Products Technology, College of Veterinary Science, GADVASU, Ludhiana, Punjab. The dressed layer carcasses were brought to the laboratory and hot deboned manually. After the removal of fascia, external fat and other connective tissue, they were packaged in low density polyethylene (LDPE) bags and stored overnight in a refrigerator at $(4\pm 1^\circ\text{C})$ for conditioning and then stored at $-18\pm 1^\circ\text{C}$ for subsequent use. The frozen deboned meat was drawn as per requirement and thawed overnight in a refrigerator $(4\pm 1^\circ\text{C})$ and was used for further study.

Spice Mix

The fresh spice ingredients were procured from local market of Ludhiana. After cleaning, the spices were oven dried at $45\pm 2^\circ\text{C}$ for 2 hours. These ingredients were then ground in domestic grinder (Inalsa, Tuareg Marketing Pvt. Ltd., Noida) and sieved through fine mesh. The fine powders of different spice ingredients so obtained were mixed in standardized proportion to prepare the spice mixture and was stored in a moisture proof PET (polyethylene terephthalate) jar till further use.

Condiment Mix

The fresh condiment powders of MDH brand were procured from local market of Ludhiana. The fine powders of different condiment ingredients so obtained were mixed in standardized proportion to prepare the condiment mixture and was stored in a moisture proof PET (polyethylene terephthalate) jar till further use.

Salt, Inulin, Refined Soybean Oil and Refined Wheat Flour

Table salt (Tata Chemicals Ltd., Mumbai), refined soybean oil (Fortune, Adani Wilmar Ltd) and refined wheat flour (Shakti Bhog maida, Kumar Food Industries Ltd., Delhi), were procured from local market of Ludhiana. Inulin was procured from Loba Chemie Pvt Ltd., Mumbai.

Packaging Materials

Low density polyethylene (LDPE/150 gauge) bags in natural color were procured from reputed firms and used for aerobic packaging and double layered laminated plastic pouches (Polyester/ Polyethylene 100/100 gauge) were procured from reputed firms and used for modified atmosphere packaging (MAP) of the product.

Chemicals, Media and Standards

All the required chemicals in the study were of analytical grade. Readymade cultures media and standards were procured from reputed firms like SRL, Qualigens, CDH, Hi-Media, Sigma-Aldrich etc.

Formulation and Processing of Kachori

Formulation of kachori mixture and kachori dough is given in Table 1 and Table 2 respectively.

Table 1: Formulation of Kachori mixture

S. No.	Name of Ingredients	Percentage (w/w)
1	Soaked black gram (1:1 hydration)	37.5
2	Soaked green gram (1:1 hydration)	37.5
3	Refined soybean oil	10
4	Spice mix	10
5	Condiment mix	3
6	Salt	2
	Total	100

Preparation of Kachori Mixture

Soaked pulses i.e. black gram and green gram in (1:1 hydration), were ground in domestic grinder (Inalsa, Tuareg Marketing Pvt. Ltd., Noida) and grounded paste is taken on already heated prestige frying pan on prestige induction heater (Prestige group Ltd., Bangalore) at 180°C, heated with refined soybean oil, till pulses mixture becomes golden brown color. Spice mix is added to it and roasted for 5 minutes with continuous stirring and kept for cooling at room temperature.

Table 2: Formulation of Kachori dough

S. No.	Name of Ingredients	Percentage (w/w)
1	Refined wheat flour	95
2	Refined soybean oil	4
3	Salt	1
	Total	100

Preparation of Chicken Meat Kachori

For the preparation of Kachori dough, refined soybean oil and luke warm water was added to refined wheat flour. The mixture was kneaded for 15 min at room temperature, after that it was kept for 30 minutes after wrapping a wet cloth to keep it moist.

For the preparation of chicken kachori mixture, deboned chicken meat was minced through 4 mm plate in meat mincer (Mado Eskimo Mew-714, Mado, Germany). The condiments mix, spice mix, refined soybean oil, salt, inulin was added as per the formulation given in Table 1. The minced meat was added in the mixture after replacing the soaked pulses in the standardized formulation of kachori. This mixture was cooked till it turns brown and later it was left for cooling. Kachori mixture and kachori dough was used in the ratio 1:1 to prepare the kachori. 20g of kachori dough was made into circular ball, was rolled and

flattened like a chapatti to be filled in by 20g of kachori mixture giving a spherical shape. The kachoris were deep fried at 180°C for 15 min, until golden brown color was developed on the surface.

Analytical Procedures

Cooking Yield

The weight of raw chicken meat kachori and cooked chicken meat kachori of each replicate was recorded. The cooking yield for each kachori was expressed as percentage by using following formula-

$$\text{Cooking Yield} = \frac{\text{Weight of cooked chicken meat kachori}}{\text{Weight of raw chicken meat kachori}} \times 100$$

Water Activity (a_w)

Water activity (n=6) was determined using hand held potable digital water activity meter (Rotronic HYGRO Palm AW1 Set/40 USA). Finely ground product was filled (80%) in a moisture free sample cup provided along with a_w meter. The sample cup was placed into the sample holder, and then sensor was placed on it for five min for measuring a_w value. Duplicate reading was performed for each sample.

pH

The pH of cooked kachori (n=6) was determined (Trout *et al.*, 1992) with pH meter (FE-20-1-KIT, Mettler-Toledo India, Pvt. Ltd., Mumbai) equipped with a combined glass electrode. 10 g of sample was homogenized with 50 ml of distilled water for 1 min using pestle and mortar. The electrode was dipped into the suspension and the pH value of the sample was recorded.

Thiobarbituric Acid Reacting Substances (TBARS) Value

The extraction method described by Witte *et al.* (1970) was used with suitable modifications for the determination of TBARS values of cooked chicken meat kachoris. 10g of sample was triturated with pestle and mortar with 25 ml of pre-cooled 20% trichloroacetic acid (TCA) prepared in 2 M orthophosphoric acid solution for 2 min. The content was then transferred quantitatively to a beaker by rinsing with 25 ml of cold distilled water, well mixed and filtered through ash less filter paper (Whatman filter paper No. 1). Then, 3 ml of TCA extract (filtrate) was mixed with equal amount of 2-thiobarbituric acid (TBA) reagent (0.005 M) in test tubes and placed in dark cabinet for 16 hrs. A blank sample was prepared by mixing 3ml of 10% TCA and 3 ml of 0.005 M TBA reagent. Absorbance (O.D.) was measured at fixed wavelength of 532 nm with a scanning range of 531 to 533 nm using UV-VIS spectrophotometer (SL-159 Elico India Ltd., Mumbai). TBA value was calculated as mg malonaldehyde per Kg of sample by multiplying O.D. value with K factor of 5.2.

Free Fatty Acids (FFA)

The method as described by Koniecko (1979) was followed for quantification of free fatty acids. For this, 5 g of

sample was blended into fine powder using anhydrous sodium sulphate and then mixed with 30 ml of chloroform for 2 min. The slurry was filtered through Whatman filter paper no. 1 into a 100 ml conical flask. About 2 or 3 drops of 0.2 % phenolphthalein indicator solution were added to the chloroform extract, which was then titrated against 0.1N alcoholic potassium hydroxide to get the pink colour end point. The quantity of potassium hydroxide required for titration was recorded and calculated as follows-

$$\text{Free fatty acid (FFA) \%} = \frac{0.1 \times \text{ml } 0.1\text{N alcoholic KOH} \times 0.282}{\text{Sample weight (g)}} \times 100$$

Instrumental Color Profile

Color profile was measured using handheld CR-400 Konica Chroma meter (Konica Minolta, Japan) set at 2° of cool white light (D₆₅) and known as L^* , a^* , and b^* values. L^* denotes (brightness 100) or lightness (0), a^* (+ redness/- greenness), b^* (+ yellowness/-blueness) values were recorded on crushed kachoris kept in a group in the petridish. The instrument was calibrated using light trap (black hole) and white tile provided with the instrument. Mean and standard error for each parameter were calculated. Hue and Chroma were calculated by following formulas-

$$\text{Hue} = \tan^{-1} (b^*/a^*)$$

$$\text{Chroma} = (a^2 + b^2)^{1/2}$$

Proximate Composition

The moisture, protein, fat, and ash content of the product was estimated using automatic moisture analyzer, Kel plus, Socs Plus and Muffle furnace, respectively following the method of AOAC (2000).

Sensory Evaluation

A seven member experienced panel of judges consisting of teachers and postgraduate students of Department of Livestock Products Technology, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University evaluated the samples for the sensory attributes viz. appearance, flavor, texture, meat flavor intensity and overall acceptability using 8-point descriptive scale (Keeton, 1983), where 8=excellent and 1=extremely poor. The test samples were presented to the panelists after assigning the suitable codes. The water was served for rinsing the mouth between the samples.

Statistical Analysis

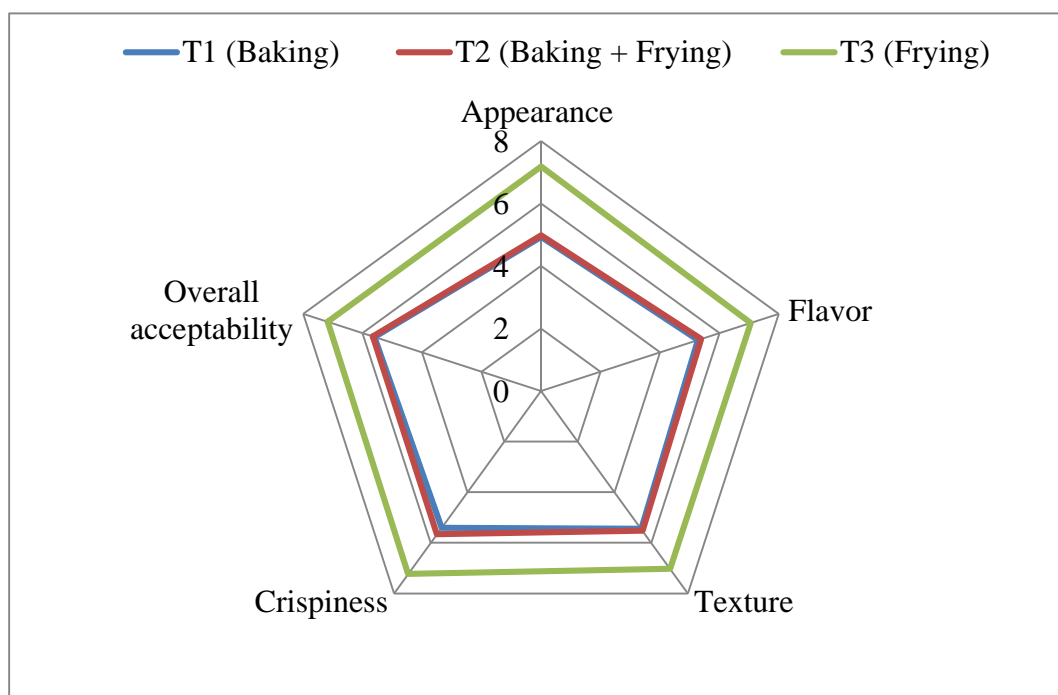
Data was analyzed statistically on 'SPSS-16.0' (SPSS Inc., Chicago, II USA) software package as per standard methods (Snedecor and Cochran, 1994). Duplicate samples were drawn for each parameter and the whole set of experiment was repeated three times to have total 6 number of observations. Sensory evaluation was performed by a panel of seven member judges, Total observations of all parameters were six (n=6) except sensory parameters where n=21 and instrumental color n = 18. The average values were reported along with standard error. Means between the period of storage, between treatments and within

treatments were compared by one way analysis of variance. The statistical significance was estimated at 5% level ($p < 0.05$) and evaluated with Duncan's Multiple Range Test (DMRT).

Results and Discussion

Standardization of the Formulation and Processing Conditions for the Development of Shelf Stable Chicken Meat Kachori

Formulation and processing protocols for the pulses based kachori was standardized on the basis of information collected from the relevant literature and various preliminary trials conducted in the Department of Livestock Products Technology. Basic formulation for the kachori mixture and kachori dough standardized for the development of kachori are given in Table 1 and Table 2 respectively. The developed product was subjected to three different cooking methods viz. baking (T_1), baking + frying (T_2) and deep fat frying (T_3). The developed product was evaluated for sensory quality attributes such as appearance, flavor, texture, crispiness and overall acceptability. The scores for sensory evaluation of developed vegetable kachori, cooked with three different methods of cooking are presented in Fig.1.



*Mean \pm S.E. with different superscripts in row-wise differ significantly ($P < 0.05$).

Fig. 1: Sensory scores of kachori prepared with three different cooking methods

Results showed that under deep fat frying, sensory scores for the parameters were higher than baking and combination of baking and frying. Sensory panelists awarded higher scores for appearance (7.18) and flavor (7.05) to kachori cooked by deep fat frying as they possessed an appealing golden brown color and the flavor was higher as frying oil improved the flavor (Pawar *et al.*, 2000). On the other hand, kachori cooked

with baking and combination of baking and frying had significantly ($P<0.05$) lower scores for appearance and flavor in comparison to T_3 . Heath (1970) reported that the difference in flavor due to cooking is probably a direct function of temperature and degree of moisture retention in the meat. Scores for texture and crispiness in T_3 were significantly ($P<0.05$) higher than T_1 and T_2 . Bahram Parvar *et al.* (2014) also reported higher crispiness scores in golden yellow colored snacks. The overall acceptability scores of the deep fat fried (T_3) kachori were significantly ($P<0.05$) higher than T_1 and T_2 , which is the reflective of scores of other sensory parameters. Bouchon and Aguilera (2001) reported that desirable characteristics of fried food are derived from the formation of a composite structure: a dry, porous, crisp and oily outer layer or crust and a moist cooked interior.

On the basis of sensory evaluation, deep fat frying method (T_3) of cooking was adjudged best for the development of kachori.

Optimization of the Level of Incorporation of Minced Chicken Meat in Standardized Formulation of Kachori

The minced chicken meat was incorporated at 55%, 65% and 75% level after replacing the pulses in the pre-standardized formulation of kachori. The developed chicken meat kachori was evaluated for its physicochemical properties (pH, cooking yield and water activity), instrumental color and sensory quality. The results for the physico-chemical quality and instrumental color profile are presented in Table 3. There was significant ($P<0.05$) increase in the cooking yield with increasing level of minced chicken meat and it was significantly ($P<0.05$) higher for kachori with 75% minced chicken meat as compared to control and other treatment products. This finding was in accordance with Ahamed *et al.* (2007) who also reported higher product yield in cutlet with higher percentage of chicken meat emulsion and hypothesized that the increase in cooking yield was due to improved water binding property of meat emulsion.

Table 3: Physico-chemical quality, instrumental color profile and sensory evaluation of kachori incorporated with three different levels of minced chicken meat (Mean \pm S.E)*

Parameters	Control	Level of Minced Chicken Meat (%)		
		T ₁	T ₂	T ₃
Cooking Yield	88.46 \pm 0.22 ^d	89.18 \pm 0.30 ^c	89.94 \pm 0.26 ^b	90.58 \pm 0.20 ^a
pH	5.46 \pm 0.05 ^a	5.38 \pm 0.02 ^b	5.37 \pm 0.01 ^b	5.35 \pm 0.03 ^b
Water Activity	0.622 \pm 0.004	0.641 \pm 0.004	0.662 \pm 0.002	0.661 \pm 0.005
Instrumental Color Profile				
Redness (a*)	12.64 \pm 0.38 ^b	12.85 \pm 0.35 ^{ab}	13.12 \pm 0.41 ^{ab}	13.28 \pm 0.57 ^a
Yellowness (b*)	42.54 \pm 0.44	42.74 \pm 0.44	42.23 \pm 0.49	42.18 \pm 0.49
Lightness (L*)	58.70 \pm 0.72	58.61 \pm 0.60	58.53 \pm 0.54	58.45 \pm 0.45
Hue	1.28 \pm 0.01	1.27 \pm 0.01	1.26 \pm 0.03	1.27 \pm 0.01
Chroma	44.37 \pm 0.49	44.63 \pm 0.30	44.22 \pm 0.45	44.21 \pm 0.37

N=6 for Physico-chemical quality, N=18 for Instrumental color profile. C= Control, T₁= 55 % minced chicken meat, T₂= 65 % minced chicken meat; T₃=75 % minced chicken meat. *Mean \pm S.E. with different superscripts row-wise differ significantly ($P<0.05$)

The pH of all the treatment products was significantly ($P < 0.05$) lower than control product. The decline in pH with increased meat contents was due to the acidic nature of chicken meat in comparison to pulses. Similar findings were reported Chin *et al.* (2012) in wet yellow noodles that incorporated *surimi* powder in preparation. Water activity showed insignificant ($P > 0.05$) increasing trend as level of minced chicken meat incorporation increased. It might be due to fact that chicken meat contains more moisture which was retained in the product even after deep fat frying.

Increasing trend was observed in the a^* (redness) with increase in the incorporation level of minced chicken meat which might be due to darker color of minced chicken meat. Treatment product with 75% minced chicken meat had significantly ($P < 0.05$) higher a^* values than other products. Whereas lightness followed insignificant ($P > 0.05$) decreasing trend with increasing level of minced chicken meat incorporation. However, the value of yellowness was comparable among control and treatment products. Addition of minced chicken meat didn't lead to any significant difference in value of Hue and Chroma since both were calculated values and depended on the respective values of a^* and b^* .

Sensory Evaluation

The scores of sensory evaluation of developed kachori incorporated with minced chicken meat in three different levels are presented in Fig. 2.

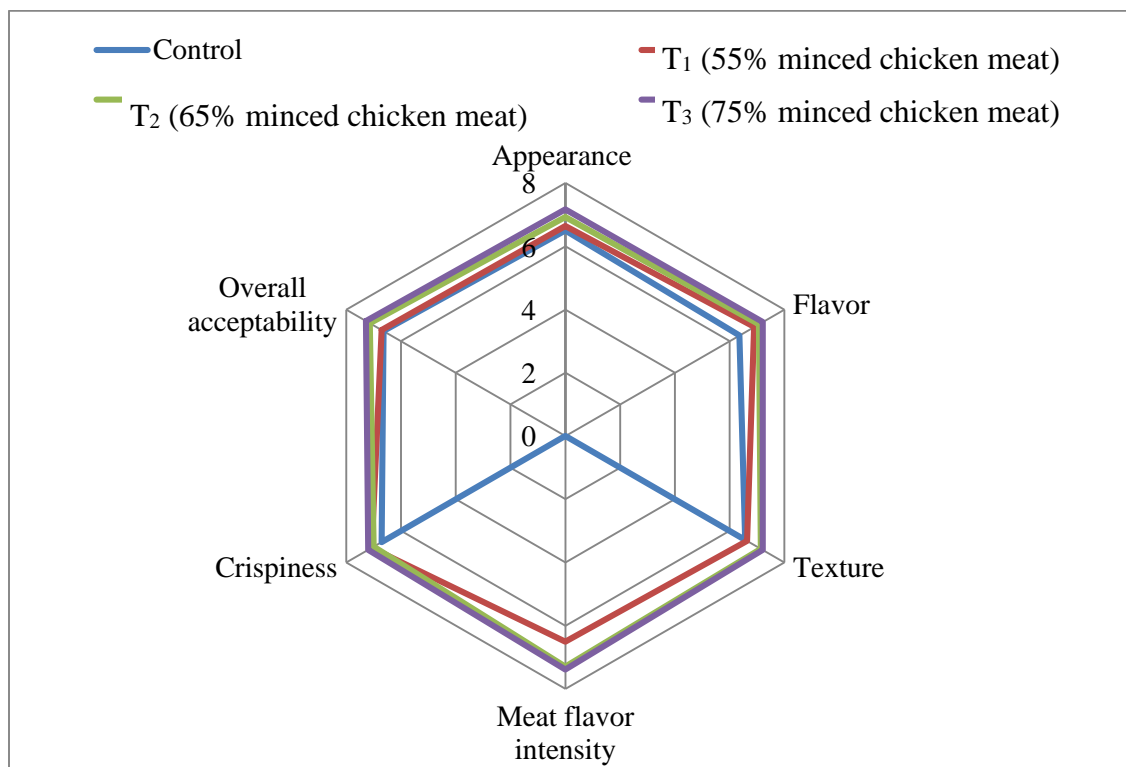


Fig. 2: Sensory scores of developed kachori incorporated with three different levels of minced chicken meat (N=21; C = Control; T₁ = 55% minced chicken meat, T₂ = 65% minced chicken meat; T₃ = 75% minced chicken meat)

The scores for all the sensory attributes showed significant ($P < 0.05$) increasing trend with increasing level of minced chicken meat in the formulation. There was significant ($P < 0.05$) increase in appearance, meat flavour intensity, texture and crispiness scores with the increase in incorporation level of minced chicken meat. Sensory scores for all the sensory attributes for T_3 were significantly ($P < 0.05$) higher than control and other treatment products. Significantly ($P < 0.05$) higher appearance scores for T_3 might be due to increase in redness value as shown in instrumental color analysis. Meat flavor intensity scores for T_3 were significantly ($P < 0.05$) higher than T_1 but the scores was comparable to T_2 which was obvious due to the incorporation of minced chicken meat at 75% level replacing all the pulses in the control formulation.

The sensory scores for all the parameters in the kachori containing 75% minced chicken meat (T_3) were highly acceptable. The overall acceptability score were significantly ($P < 0.05$) higher for the kachori having 75 % minced chicken meat (T_3) as compared to the other treatment and control products which is reflective of scores of other sensory parameters. On the basis of results of physico-chemical, instrumental color profile and sensory scores, the incorporation of minced chicken meat at 75% level was adjudged best for the development of chicken meat kachori.

Optimization of Level of Inulin in Chicken Meat Kachori for the Development of Prebiotic Enriched Functional Chicken Met Kachori

Inulin was incorporated at three different levels i.e. 2%, 4% and 6% in the pre-standardized formulation of chicken meat kachori after replacing the minced chicken meat in the formulation. Developed product was evaluated for physico-chemical quality (pH, cooking yield and water activity), proximate analysis and sensory parameters (8- point descriptive scale). The results are presented in Table 4.

Physico-Chemical Quality

Cooking yield of chicken meat kachori increased significantly ($P < 0.05$) with increasing incorporation level of inulin powder in the formulation. Cooking yield of T_3 was recorded significantly ($P < 0.05$) higher than control and other treatment products. It might be due the capacity of gums to bind and hold water due to their ability to form hydrogen bonds with water (Xiong *et al.*, 1999). Similarly, Garcia-Garcia and Totousaus (2008) reported that this phenomenon could be attributed to the denaturation of meat proteins before gelatinization of other ingredients in the polysaccharide-meat system.

Addition of inulin powder didn't result in any significant ($P > 0.05$) effect on the pH of the products, which could be attributed to the neutral nature of added inulin powder. pH of control and treatment products were comparable among each other. The water activity (a_w) showed significantly ($P < 0.05$) increasing trend as the level of incorporation of inulin powder increased in products. This increase in water activity (a_w) might be due to improved water binding property of added inulin powder (El-Nagar *et al.*, 2002). The water

activity (a_w) for treatment products were comparable, although water activity of T_3 was significantly ($P<0.05$) higher than the control product.

Table 4: Physico-chemical properties and proximate analysis of chicken meat kachori incorporated with three different levels of Inulin (Mean \pm S.E.)*

Parameters	Control	Levels of Inulin (%)		
		T ₁ (2% Inulin)	T ₂ (4% Inulin)	T ₃ (6% Inulin)
Physico-chemical properties				
Cooking Yield	88.36 \pm 0.07 ^c	88.51 \pm 0.30 ^c	89.67 \pm 0.17 ^b	90.59 \pm 0.19 ^a
pH	5.33 \pm 0.03	5.40 \pm 0.01	5.36 \pm 0.03	5.35 \pm 0.04
Water activity	0.601 \pm 0.005 ^b	0.642 \pm 0.004 ^{ab}	0.671 \pm 0.002 ^{ab}	0.692 \pm 0.001 ^a
Proximate Analysis				
Moisture	21.91 \pm 0.20 ^c	22.16 \pm 0.12 ^{bc}	22.23 \pm 0.11 ^b	23.31 \pm 0.13 ^a
Crude protein	22.33 \pm 0.29 ^a	20.19 \pm 0.30 ^b	19.40 \pm 0.24 ^c	18.92 \pm 0.16 ^c
Crude fiber	3.42 \pm 0.02 ^d	5.01 \pm 0.03 ^c	5.12 \pm 0.02 ^b	5.27 \pm 0.02 ^a
Fat	20.77 \pm 0.14 ^a	20.69 \pm 0.09 ^a	20.09 \pm 0.19 ^b	19.33 \pm 0.15 ^c
Ash	3.08 \pm 0.04 ^d	3.14 \pm 0.01 ^c	3.24 \pm 0.01 ^b	3.30 \pm 0.02 ^a
Moisture: protein	0.97 \pm 0.04 ^c	1.09 \pm 0.01 ^b	1.12 \pm 0.02 ^{ab}	1.22 \pm 0.01 ^a

*Mean \pm S.E. with different superscripts row-wise differ significantly ($P<0.05$); N=6; C= Control, T₁= 2 % Inulin, T₂= 4 % Inulin; T₃=6 % Inulin

Proximate Analysis

Addition of inulin powder resulted in significant ($P<0.05$) effects on the proximate composition of the chicken meat kachori. The moisture percent increased significantly ($P<0.05$) with the increasing incorporation level of inulin powder in the formulation of chicken meat kachori. Moisture percent in T_3 was recorded significantly ($P<0.05$) higher than control and other treatment products. It might be due to the hygroscopic and water holding capacity of the inulin. El-Nagar *et al.* (2002) reported that inulin is hygroscopic in nature and could bind water and form a gel-like network. Similar, behavior was reported by Mendez-Zamora *et al.* (2015) in frankfurter sausages after incorporation of inulin. Similarly, Vural *et al.* (2004), Choi *et al.* (2009) and Choi *et al.* (2010) reported the increase in moisture content of sausages after incorporation of rice bran fiber.

Crude protein percent showed significantly ($P<0.05$) declining trend as the incorporation level of inulin increased. The decrease in the crude protein percent might be due to decreased levels of minced chicken meat (source of crude protein) and higher moisture level in treated products. Crude protein percent for control was significantly ($P<0.05$) higher than other treatment products. Crude fibre percent showed significantly ($P<0.05$) increasing trend with increase in incorporation level of inulin in the formulation of chicken meat kachori. The crude fibre percent of treatment products was significantly ($P<0.05$) higher than control. Crude fibre percent of T_3 recorded highest crude fibre percent than control and other treatment products. This may be attributed to incorporation of inulin which is a source of prebiotic fibre.

On the contrast, fat percent showed decreasing trend as the level of incorporation of inulin powder increased. Fat percent of control and T₁ were comparable however, fat percent of control was significantly (P<0.05) higher than T₂ and T₃. It might be attributed to the fat replacing quality of inulin powder in the products. Kaur and Gupta (2002) also reported that inulin can be used successfully to replace fat in dairy products, especially cheese (Salvatore *et al.*, 2014) and ice-cream (El-Nagar *et al.*, 2002). Bi *et al.* (2016) also reported that inulin could be used to replace up to 7.2% of the fat in imitation cheese. Similarly, Cegiela *et al.* (2012) also reported that there was inverse relation between content of fat and moisture in different types of meat products formulated with inulin. The results obtained in the present study are in agreement with Beriain *et al.* (2011) who found that addition of inulin significantly decreased the content of fat and protein, and increase the moisture content of raw fermented sausage.

Ash percent also showed significantly (P<0.05) increasing trend as the level of incorporation of inulin powder was increased. Ash percent of T₃ was significantly (P<0.05) higher than control and other treatment products. Similar results were reported by Mendez-Zamora *et al.* (2015) in-frankfurter sausages after incorporation of inulin. Similarly, moisture to protein ratio also showed increasing trend as the level of incorporation of inulin powder increased. It might be attributed to increasing moisture percent and decreasing protein percent as the level of incorporation of inulin powder increased. Moisture to protein ratio in T₃ was significantly (P<0.05) higher than control and other treatment products.

Sensory Evaluation

The scores for sensory evaluation of chicken meat kachori incorporated with three different levels of inulin powder are presented in Fig. 3. The results of sensory evaluation showed that addition of inulin didn't affect sensory parameters significantly (P>0.05) till 4% level of incorporation of inulin but at 6 % level of incorporation of inulin, it lead to overall decline in sensory scores of chicken meat kachoris. Sensory scores of control, T₁ and T₂ were comparable to control product but it was significantly (P<0.05) lower in T₃. Appearance scores for control, T₁ and T₂ was significantly (P<0.05) higher than T₃, whereas the scores were comparable among themselves. It might be due to increase in dark brown color of kachori mixture as the level of incorporation of inulin powder increased.

Flavour scores and meat flavour intensity scores showed slightly declining trend as the incorporation level of inulin increased in the formulation of chicken meat kachoris till 4% level but decreased significantly (P<0.05) in T₃ product. Sensory scores of flavour and meat flavour intensity for control recorded significantly (P<0.05) higher scores than T₃ but the scores were comparable to T₁ and T₂. It might be due to sweetness imparted by inulin and decreasing level of minced chicken meat content in the kachoris. Ozturk (2016) reported that standard inulin has a slight sweetness (10% compared to sugar). Texture scores too showed decreasing trend as the level of incorporation of inulin powder increased in the chicken meat

kachoris. Texture scores for control recorded significantly ($P<0.05$) higher scores than T_3 but the score were comparable to T_1 and T_2 . It might be due to increase in moisture percent of chicken meat kachoris as the level of incorporation of inulin powder increased. The overall acceptability scores for T_1 and T_2 was comparable to control but the scores for the T_3 was significantly ($P<0.05$) lower than the control which is reflective of scores of other sensory parameters. Although control, T_1 and T_2 were sensory acceptable, but the aim of present study was to maximize inulin powder incorporation without affecting the sensory attributes, hence the chicken meat kachori with 4% inulin (T_2) was selected for the development of prebiotic enriched chicken meat kachori.

The 4% level of incorporation of inulin was standardized on the basis of physico-chemical properties, instrumental color profile and sensory evaluation for the development of prebiotic enriched chicken meat kachori.

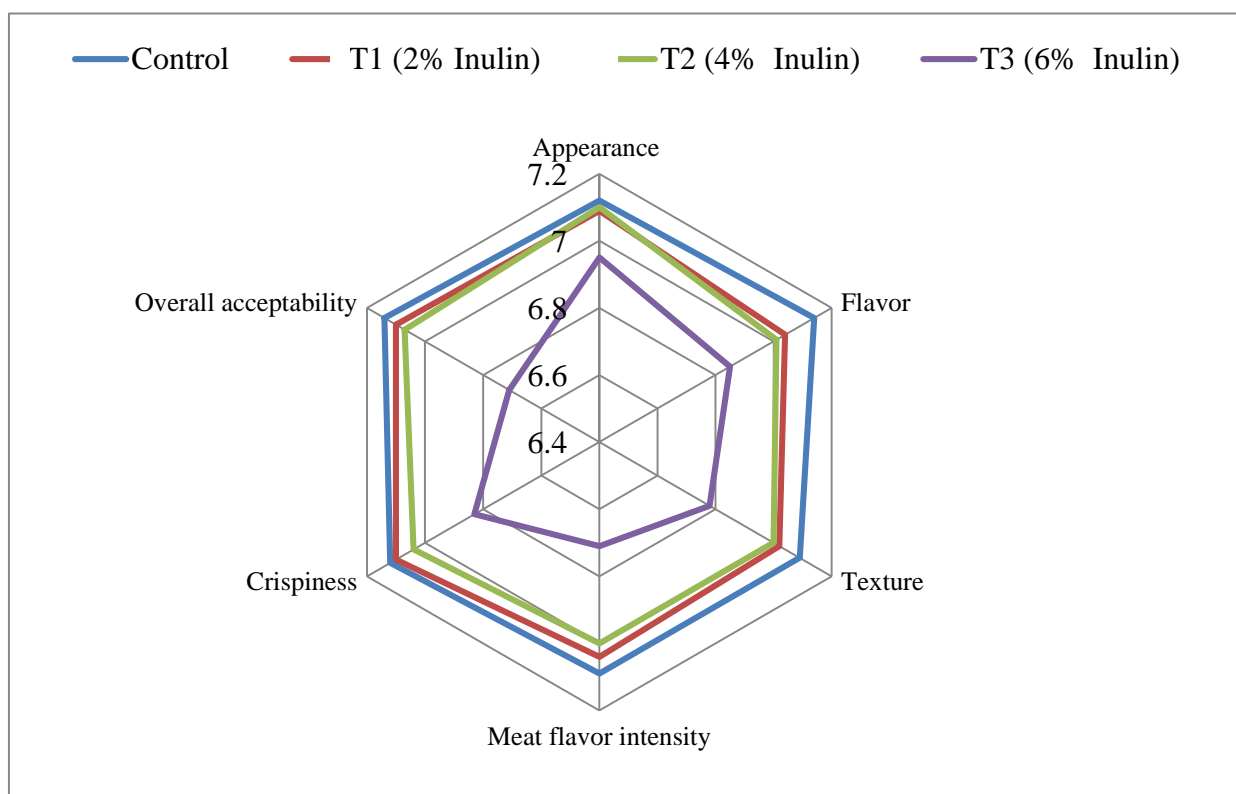


Fig. 3: Sensory scores of chicken meat kachori incorporated with three different levels of Inulin (N=21; C= Control, T_1 = 2 % Inulin, T_2 = 4 % Inulin; T_3 =6 % Inulin; *Mean \pm S.E. with different superscripts in row-wise differ significantly ($P<0.05$).

Conclusion

Development of shelf-stable chicken meat kachori incorporated with inulin was an innovative approach to provide a product which will provide all the appropriate nutrients in a convenient form to the consumers.

On the basis of sensory evaluation, frying method (T_3) of cooking was most suitable for the development of kachori. The incorporation of minced chicken meat at 75% level was found most suitable for the development of meat kachori. For the incorporation of prebiotic fiber for additional health benefits, inulin was incorporated at 4% level.

Conflict of Interest: There is no conflict of interest among the authors.

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