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Development and quality evaluation of spent hen meat spread incorporated with corn starch

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ABSTRACT

Three different levels of corn starch i.e. 4%, 6% and 8% was incorporated after replacing meat in the formulation of spent hen meat spread (SHMS). The lowest scores for most of the sensory parameters were observed in product with 4% level of corn starch whereas the product with 6% corn starch level had highest scores for all the sensory parameters. Lightness values of SHMS increased significantly (P<0.05) with increase in level of corn starch level, whereas the redness (a^*) and yellowness (b^*) values decreased significantly (P<0.05) with the addition of corn starch. The pH of the treated spent hen meat spread showed significantly (P<0.05) declining trend on incorporation of corn starch. Cooking yield and moisture content showed increasing trend with the increase in the incorporation level of corn starch. Protein and fat values were recorded lower in treatment products in comparison to control product. On basis of analysis of sensory parameters, instrumental colour profile, physico-chemical properties and proximate composition, the incorporation of corn starch at 6% level was found best for the preparation of excellent quality spent hen meat spread.

Key words: Acceptability, instrumental colour, proximate, starch and sensory quality.

INTRODUCTION

India is the third-largest producer of eggs and the fifth-largest producer of poultry meat (BAHS 2020). Poultry production is gaining relevance in the current environment, with rapid increase in consumption in both developed and emerging countries, particularly in India. Layer meat is generally considered as by-product of the egg industry and it is sold at thrown away prices in the open market. With the rapid growth of poultry industry, the availability of spent layers and breeding stock has increased. The meat from the spent poultry birds has less desired palatability features, the meat from these birds is deemed low grade and sold at a cheaper price due to its fibrous nature. Spent chicken meat is generally not consumed by humans, but around 2.6 billion metric tons of spent hen meat is consumed by the pet food industry (Navid et al. 2011). Spent hen meat is very important by-product of poultry industry; its utilization for the human consumption may be increased by employing certain processing techniques. It will increase the profitability of poultry farmers (Kondiah 2010).

Meat from spent hen is a good source of proteins (Lee et al. 2003), it is high in omega-3 fatty acids, and has a lower cholesterol level (Ajuyah et al. 1992). Currently, spent hen meat is used to make comminuted and emulsified products, as well as chicken soups. Only about 20% of poultry meat is processed into poultry meat products at the moment (Desikan and Megarajan 2014). It is intended that when these product ideas are turned into actual products, they will add value to meat products, boosting market share for the Indian meat sector by generating new market segments. It is necessary to list features in the product that will enhance the sensory quality, acceptance, and stability of the product. Foods with high natural protein content might provide a higher nutritional value to a market for chutney-like products that can be used with rotis and breads, since many products currently have high fat, carbohydrate, and sugar content.

The inclusion of novel non-meat components has been prompted by the rising demand for healthier meat products with inclusion of natural plant materials as the source of bioactive compounds. The primary plant materials frequent utilized to prepare different functional meat products are cereal grains (Ding et al. 2006, Heginama et al. 2006). The major carbohydrate found in the majority of grains and tubers is starch. It absorbs a lot of water and turns into gelatin when heated. Different types of starch have different granule sizes, shapes, and gelatinization characteristics (Hosenney, 1994). Starch is added to meat products as binder and extender to enhance quality and to replace expensive meat. Starches are versatile food ingredients with a variety of uses, such as adhesion, binding, emulsion stability, gelling, and moisture retention (Pietrasik, 1999).

Over 85% of the starch produced worldwide comes from corn, which is the primary source. Corn starch, a carbohydrate fat substitute, is well known for its ability to bind water. The property of gelatinization and absorption of water and fat which makes it effective in high moisture systems like low-fat spreads and meat emulsions (Giese, 1996). Dexter et al. (1993) found that turkey bologna containing 2% modified waxy maize starch had lower purge during refrigerated storage and after freeze/thawing support the beneficial effect of modified waxy maize starch on reducing purge loss. Prabhu and Sebranek (1997) also reported that using modified corn starch in ham at levels of 2, 3.5, and 5% resulted in increased cooking yield of the product. In light of the above discussion present study was planned to develop good quality meat spread by utilizing spent hen meat and corn starch.

MATERIALS AND METHODS

Source of raw material

Spent hen meat

Spent hen reared under similar feeding and managemental conditions were obtained from the poultry farm of Department of Livestock Production Management, College of Veterinary Science, GADVASU, Ludhiana. Spent hens above 52 weeks of age and weighing between 4.5-5 kg were slaughtered in the experimental abattoir of the Department of Livestock Products Technology, GADVASU under standard conditions. The dressed carcass obtained was kept at 4±1°C for 24 hrs after packing in low density polyethylene (LDPE) bags. Later the meat was portioned after removing separable fat and connective tissue and kept in LDPE bags at freezing temperature of -18±1°C till further studies.

Additives and other ingredients

Table salt (Tata Chemicals Ltd., Mumbai), refined oil (Patanjali) and refined wheat flour were procured from the local market.

Condiments mix

Fresh onion, garlic and ginger were procured from the local market of Ludhiana. These were separately peeled and a fine paste was prepared in domestic grinder (Bajaj-make). The condiment mix was prepared by mixing onion, garlic and ginger paste in 2:2:1 ratio and packed in LDPE bags and stored at -18±1°C till further use.

Spice mix

The spices were procured from local market of Ludhiana. After cleaning, the spices were oven dried at 45±2°C for 2 hours. These ingredients were then ground in domestic grinder (Bajaj-make) and sieved through fine mesh. The fine powders of different spice ingredients so obtained were mixed in pre-standardized proportion to prepare the spice mixture and was stored in a moisture proof PET (polyethylene terephthalate) jar till further use.

Corn starch

Corn starch was purchased from the Hi-media.

Preparation of spent hen meat spread

The method of Kumar et al. (2015) was utilized for the preparation of spent hen meat spread with some modifications. The basic formulation of spent hen meat spread

Table 1: Formulation of spent hen meat spread prepared using corn starch

Ingredients	Control	4% Corn starch	6% Corn starch	8% Corn starch
Chicken meat	60	56	54	52
Salt	1.5	1.5	1.5	1.5
Spice mix	2.5	2.5	2.5	2.5
Condiments	5.00	5	5	5
Refined vegetable oil	5	5	5	5
Refined wheat flour	5	5	5	5
Corn starch	0	4	6	8
Water	21.00	21.00	21.00	21.00
Total	100	100	100	100

(Table 1) was developed as a result of several preliminary trials in the Department of Livestock Products Technology, GADVASU. After trimming off all of the visible fat, fascia, and connective tissue, the deboned meat was minced twice through a 4.5 mm sieve (MA Eskimo, Germany). To create a batter in which all the components are combined, the minced meat and ingredients were accurately weighed and mixed. Then, for 20 minutes, this was steam cooked in an autoclave at 121°C. The material was cooked before being ground into a fine paste-like consistency for 3–4 minutes in a grinder. The cooked products were packaged in food-grade PET jars and kept refrigerated at a temperature of 4°C.

Analytical procedures

Cooking yield

To calculate the cooing yield, the weight off meat pieces/ product was recorded before and after cooking, and the yield was expressed as a percentage.

Cooking yield %= (Weight of cooked product /weight of raw uncooked product) X 100

Proximate composition:

The proximate composition (moisture, crude protein, ether extract, and ash) was estimated using the AOAC's recommended procedures (2000).

Instrumental color profile

Using a CR 400 Konica Chroma meter (Konica, Minolta, Japan) set at 2°C of cool white light and known as L*, a* and b* values. With diffuse illumination, the spread samples' colour was measured objectively. With an aperture size of 2.54 cm and an illuminant of 45/0, the device was configured to measure Hunter L, a, and b. It was calibrated using black and white tiles, and the colorimeter score was recorded with "L" of black equalling 0 and "L" of white equalling 100. Additionally, "a" of lower numbers = more green (less red), "b" of higher numbers equals more red (less green), and "L" of black equals 100. The samples' colour L (lightness), a (redness), and b' (yellowness) were measured three times, and mean values were calculated. The hue angle and chroma values were calculated using the formulas: Hue angle = $\tan^{-1}$ (b* / a*)

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

Sensory evaluation

A seven-member experienced panel of judges consisting of faculty members and postgraduate students of Department of Livestock Products and Technology (LPT), College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University evaluated the samples for the sensory attributes viz. colour and appearance, flavour, texture, after taste, adhesiveability and overall acceptability using 8 point descriptive scale for product (Keeton 1994), where 8=excellent and 1=extremely poor. The spent hen meat spread samples were warmed in a microwave oven for 20 sec before serving to the sensory panellists.

Statistical analysis

Data was statistically evaluated using the SPSS-20.0 programme (SPSS Inc., Chicago, USA) in accordance with accepted practises (Snedecor and Cochran, 1980). The average values and standard deviation were provided. The 5% level (P 0.05) was used to determine the statistical significance.

RESULTS AND DISCUSSION

Different levels of corn starch i.e. 4%, 6% and 8% level was incorporated in prestandardized formulation of spent hen

meat spread. These developed products were evaluated for sensory qualities (appearance, flavour, texture, after taste, spreadability and overall acceptability), instrumental colour analysis, physico-chemical properties (pH, cooking yield), proximate composition (moisture, protein, fat, ash). The results are presented in Table 2-4.

Sensory evaluation of spent hen meat spread incorporated with corn starch

The scores of the sensory parameters (appearance, flavour, texture, spreadability, after taste, adhesivebility and overall acceptability) for spent hen meat spread incorporated with three different levels of corn starch i.e. 4%, 6% and 8% are presented in Table 2. Sensory scores for all the sensory attributes of spent hen meat spread varied significantly (P<0.05) with the addition of different levels of corn starch.

Highest value for appearance score of spent hen meat spread was observed in product with 6% corn starch level i.e. 7.50. Lowest value for color of spent hen meat spread was observed in product with corn starch at 4% i.e. 6.55. The enhancement of appearance scores might be due to the decrease in fat content which in turn increase the redness of the product (Hughes et al., 1998). Similar enhancement in colour and appearance scores with the incorporation of fat replacers has been documented by Verma et al. (2015) in low fat pork patties. Similar to the appearance scores, spent hen meat spread incorporated with 6% corn starch had significantly (P<0.05) higher flavour scores as compared to other treatment and control products. It might be due to the considerable swelling of the starch granules during cooking. Hughes et al. (1998) also reported increased flavour intensity of frankfurters incorporated with starch. Treatment products had higher scores of texture at 6% and 8% level of incorporation. Giese (1992) also emphasized that modified food starches have been used as binders to maintain tenderness in low fat meat products.

Spreadability indicates the ease of spread of product with a knife onto foods such as bread and toasts. The lowest scores for spreadability observed in T-1 with 4% corn starch level i.e. 6.55 and the highest scores for spreadability was observed in T-2 with 6% corn starch level i.e. 7.52. After taste scores showed increasing trend with the increase in starch level but at highest starch level incorporation after taste scores were lower which might be due to the dilution of meat proteins with starchy flour. Scores for adhesive ability of control and 8% corn starch level were having values 6.90 and 7.00 respectively indicating non-significant difference with each other. The increase in the adhesivebility scores upon increase in the level of corn starch might be due to the gel formation among starch granules and meat proteins. Overall acceptability scores are the reflection of scores of other sensory parameters. As observed in the sensory scores for other parameters, lowest overall acceptability scores were observed for T-1 (4% corn starch level) i.e. 6.52. Highest overall acceptability scores were observed for T-2 (6% corn starch level) was 7.50. The spent hen meat spread incorporated with corn starch at 6% level showed the significantly (P<0.05) higher scores for all the parameters as compared to other treatment and control products.

Instrumental colour profile of spent hen meat spread incorporated with different levels of corn starch

The different colour parameters i.e., L^*, a^* and b^* values presented in Table 3 differed significantly (P<0.05) due to incorporation of different levels of corn starch. Lightness values of SHMS increased significantly (P<0.05) with

Table 2: Sensory evaluation of spent hen meat spread incorporated with different levels of corn starch

Parameters	Sensory analysis			
	Control	T_1 (4% Corn Starch)	T_2 (6% Corn Starch)	T_3 (8% Corn Starch)
Color/appearance	6.79±0.05^c	6.55±0.10^c	7.50±0.08^a	7.00±0.07^b
Flavour	6.86±0.06^b	6.50±0.09^c	7.48±0.08^a	6.98±0.07^b
Texture	6.90±0.06^b	6.55±0.08^c	7.50±0.08^a	6.98±0.08^b
Spreadability	6.90±0.06^b	6.55±0.08^c	7.52±0.08^a	7.00±0.10^b
After taste	6.86±0.07^b	6.55±0.09^c	7.48±0.08^a	7.00±0.09^b
Adhesivebility	6.90±0.06^b	6.52±0.09^c	7.50±0.08^a	7.00±0.08^b
Overall acceptability	6.90±0.07^b	6.52±0.09^c	7.50±0.08^a	7.00±0.09^b

n=21; *Mean±S.E. with different superscripts differ significantly (P<0.05)*.

increase in level of corn starch. Lowest (lightness) values were observed in control while highest values for T-3 which shows that incorporation of corn starch resulted in lighter colored meat spread which might be due to the white colored flour incorporation. Redness (*a**) values were decreased significantly (P<0.05) with the addition of corn starch, higher the level of corn starch lowers the redness values. Hughes et al. (1998) reported that the addition of 3% tapioca starch decreased the redness and lightness of frankfurters but did not significantly alter their yellowness. Yellowness (*b**) decreased significantly (P<0.05) from 15.47 to 13.23 with the increase in incorporation level of corn starch. Similarly, Zhang et al. (2013) reported that addition of tapioca starch, potato starch, and corn starch (3–9% w/w) resulted in significant increases in L* values and decreases in a* and b* values regardless of the starch type and concentration in surimi-beef gels.

Physico-chemical properties and proximate composition of spent hen meat spread incorporated with different levels of corn starch

The values for physico-chemical parameters (pH, cooking yield and water activity) and proximate composition (moisture, protein, fat, ash and moisture protein ratio) of spent hen meat spread (SHMS) incorporated with three different levels of corn starch are presented in Table 4.

The pH of the treated spent hen meat spread showed significantly (P<0.05) declining trend on incorporation of corn starch. The pH of the SHMS ranged from 6.43 to 6.23. The lowest pH scores were found in T-3 i.e. 6.23. The highest pH values were found in control and T-1 product i.e. 6.43 and 6.43 respectively. The pH values of T-2 and T-3 was significantly (P<0.05) lower than the control and T-1 products. As the starch level increased in meat spread from 4 to 8%, pH values were decreased. The pH values reported in the present study are in accordance with Pietrasik and Janz (2010), Chatterjee et al. (2019), Chin et al. (1999) in reduced fat mortadella. Arya et al. (2017) also reported the lower pH (6.38) for the meat spread incorporated with 2% potato starch.

Cooking yield

Cooking yield followed increasing trend with the increase in the incorporation level of corn starch and the values were significantly (P<0.05) higher in the treatment product *i.e.* from 91.17 to 93.70%. The lowest value for cooking

Table 3: Effect of incorporation of different levels of corn starch on instrumental colour profile of spent hen meat spread (Mean±S.E.)*

Parameters	Instrumental color profile			
	Control	T_1 (4% Corn Starch)	T_2 (6% Corn Starch)	T_3 (8% Corn Starch)
Lightness	47.70±0.72^a	49.59±0.53^b	51.94±0.47^c	54.33±0.46^d
Redness (a*)	5.06±0.19^c	3.68±0.08^b	3.56±0.19^b	3.37±0.07^a
Yellowness (b*)	15.47±0.26^b	14.61±0.32^{ab}	13.65±0.38^a	11.23±0.21^a
Hue	0.05±0.00^a	0.07±0.00^c	0.07±0.00^c	0.06±0.00^b
Chrome	16.28±0.92^d	15.07±0.29^c	14.11±0.30^b	11.72±0.11^a

n=6; C= Control (refined wheat flour); T-1= 4% corn starch; T-2= 6% corn starch; T-3= 8 % corn starch. *Mean±S.E. with different superscripts differ significantly (P<0.05).

Table 4. Effect of incorporation of different levels of corn starch on physico-chemical properties and proximate composition of spent hen meat spread (Mean±S.E.)*

Parameters	Physico-chemical properties			
	Control	T_1 (4% CS)	T_2 (6% CS)	T_3 (8% CS)
pH	6.43±0.02^c	6.43 ±0.01^c	6.32±0.02^b	6.23±0.02^a
Cooking Yield (%)	90.16±0.12^a	91.17±0.70^b	92.76±0.27^c	93.70±0.27^d
	Proximate composition			
Moisture (%)	76.15±0.09^a	76.52±0.13^{ab}	76.81±0.21^{bc}	77.12±0.10^c
Protein (%)	12.11±0.12^c	11.59±0.05^b	11.42±0.08^{ab}	11.28±0.07^a
Fat (%)	6.39±0.07	6.29±0.04	6.25±0.03	6.23±0.07
Ash (%)	2.29±0.04	2.27±0.02	2.25±0.07	2.22±0.04
Moisture: Protein	6.28±0.09^a	6.60±0.13^b	6.72±0.21^b	6.83±0.10^c

n=6; C= Control; T-1= 4% corn starch; T-2= 6% corn starch; T-3= 8 % corn starch. *Mean±S.E. with different superscripts differ significantly (P<0.05).

yield observed in control spent hen meat spread i.e. 90.16% whereas the highest value for cooking yield of spent hen meat spread observed in T3 i.e. 93.70. Both the control and T3 values were having a significant (P≤0.05) difference with each other. Carballo et al. (1995) also reported that increased levels of starch favorably affected cooking loss and purge loss. Chatterjee et al. (2019) also reported that addition of corn starch and tapioca starch caused the increase in product yield. Pietrasik and Janz, (2010) also reported that use of plant-based starch ingredients as non-meat components in the formulation could improve the water-binding ability of emulsified meat products.

Proximate composition

The moisture content of the spent hen chicken meat spread increased significantly (P<0.05) with increasing level of corn starch in the formulation. The control had lowest moisture content (76.15%) whereas T-3 with 8% corn starch had the highest moisture content (77.12%). It could be due to the more water binding property of starchy flour. The thermal treatment of spent hen meat spread forms gel like structure which holds water and consequently higher moisture content in the product. Martin et al. (2000) also observed that 5% potato starch incorporation in pork batter significantly improved the moisture retention. Contrary to the present study, Pandey et al. (2016) reported the moisture level of 52.3% in the meat spread.

Protein values showed a significantly (P<0.05) decreasing trend with increase in the level of incorporation of corn starch. The values were found lower in treated products than control due to addition of carbohydrate rich flour. Highest protein content was found in control i.e.12.11% and lowest protein was found in T-3 i.e. 11.28%. Both the control and T3 were having a significant (P≤0.05) difference with each other. The protein content of spread developed by Pandey et al. (2016) was reported to have 17.8% protein content in a product containing 65% lean meat.

The fat content was non-significantly (P>0.05) reduced among all the treatment products due to the incorporation of corn starch. The fat content ranges between 6.39% in control (highest) and 6.23% in T-3 (lowest). The value of ash content for the control and treatment product were in the range of 2.29 to 2.22 for control to T-3 spent hen meat spread incorporated with 8% corn starch. There was non-significant (P>0.05) decreasing trend was noticed in the ash content values with the increase in the incorporation level of corn starch.

Kumar et al. (2015) also reported the following values for the proximate composition of ready-to-eat meat spread incorporated with 2.97% corn starch; moisture (58.75±0.32%), crude protein (9.12±0.44%), ether extract (11.19±0.16%), and total ash (2.35±0.17%).

Lowest value for moisture protein ratio was found in control i.e.6.28 and highest for T3 i.e. 6.83. Both the control and T3 were having a significant (P≤0.05) difference with each other. Moisture-protein ratios increased significantly (P<0.05) with increased in corn starch level in spent hen meat spread formulation and recorded as per the calculations based on the respective moisture and protein values of the spent hen meat spread.

CONCLUSION

On basis of analysis of sensory parameters, instrumental colour profile, physico-chemical properties and proximate composition of spent hen meat spread incorporated with corn starch, the SHMS incorporated with corn starch at 6% level was found best for the preparation of excellent quality of product.

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