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Development and Quality Evaluation of Spent Hen Meat Spread Incorporated with Rice Starch

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Abstract

After substituting the chicken meat in the recipe for the spent hen meat spread, three different amounts of rice starch -3%, 5%, and 7% were added. The product with a 3% level of rice starch received the lowest ratings for the majority of the sensory parameters, whereas the product with a 5% level of rice starch obtained the greatest scores for every sensory parameter. The inclusion of rice starch resulted in a considerable decrease (P<0.05) in the redness (a) and yellowness (b*) values of the spent hen meat spread, while it considerably increased (P<0.05) in the lightness values. When rice starch was added, the pH of the treated spent hen meat spread showed a significantly (p<0.05) falling trend. As the amount of rice starch was increased, there was an upward trend in both cooking yield and moisture content. When comparing treated items to control products, lower protein and fat values were noted. Rice starch at a level of 5% was shown to be the most effective way to prepare high-quality leftover hen meat spread based on an analysis of sensory characteristics, instrumental color profile, physicochemical qualities, and proximate composition.*

Keywords: Acceptability, Instrumental Colour, Proximate, Starch, Sensory Quality.

Introduction

India is the third largest producer of eggs and the fifth largest producer of poultry meat (BAHS, 2023). 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 throw away prices in the open market. With the rapid growth of poultry industry, the availability of spent layers and breeding stockhas 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 sector (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 has a reduced level of cholesterol and is rich in omega-three fatty acids. (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). Rice grains eating and cooking qualities are determined by starch. Zhang *et al* (2016) also reported that addition of modified starch in blueberry jam had positive impact on product stability, spreadability and texture. Under this study rice starch was used for the preparation of spent hen meat spread.

Materials and Methods

Source of Raw Material

Spent Hen Meat

Spent hens 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.

Extenders and Other Ingredients

Table salt (Tata Chemicals Ltd., Mumbai), refined oil (Patanjali) and refined wheat flour were procured from the local market of Ludhiana. Rice starch was purchased from the Hi-media.

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 (Bajajmake). 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 were stored in a moisture-proof PET (polyethylene terephthalate) jar till further use.

Preparation of Spent Hen Meat Spread

The method of Kumar *et al.* (2015), with some modifications, was utilized for the preparation of spent hen meat spread. The basic formulation of spent hen meat spread (Table 1) was developed as a result of several preliminary trials in the Department of Livestock Products Technology, GADVASU, Ludhiana. 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.

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

Ingredients	**Control**	**T-1 (3% rice starch)**	**T-2 (5% rice starch)**	**T-3 (7% rice starch)**
Chicken meat	60	57	55	53
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 veg oil	5	5	5	5
Refined wheat flour	5	5	5	5
Rice starch	0	3	5	7
Water	21.00	21.00	21.00	21.00
Total	100	100	100	100

Analytical Procedures

Cooking Yield

To calculate the cooing yield, the weight of product (SHMS) 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 = $\tan^{-1} (b^* / a^*)$

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 secs before serving to the sensory panelists.

Statistical Analysis

Data was statistically evaluated using the SPSS-20.0 programme (SPSS Inc., Chicago, USA) following accepted practices (Snedecor and Cochran 1995). 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 rice starch, i.e., 3%, 5%, and 7% levels were incorporated in prestandardized formulation of spent hen meat spread. These developed products (control and treatment) were evaluated for sensory qualities (appearance, flavor, texture, after taste, spreadability and overall acceptability), instrumental color 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 Rice 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 rice starch i.e. 3%, 5% and 7% 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 rice starch.

Highest value for appearance score of spent hen meat spread was observed in product with 5% rice starch level i.e. 7.57. Lowest value for color of spent hen meat spread was observed in product with rice starch at 3% i.e. 6.55. Eliasson (2006) also reported that rice starch after gelatinization gives fine creamy texture, to the meat products, thus improved the overall appearance of the meat spread. 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 decline in appearance score of spent hen meat kachori on incorporation of inulin powder was also reported by Poodari *et al* (2018).

Similar to the appearance scores, spent hen meat spread incorporated with 5% rice starch had significantly ($P<0.05$) higher flavour scores as compared to other treatment and control products. The highest flavor scores of spent hen meat spread was found in product with rice starch at 5% level i.e. 7.55. 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 5% and 7% level of incorporation. Giese (1992) also emphasized that modified food starches have been used as binders to maintain tenderness in low fat meat products. Eliasson

(2006) reported that rice starch has significantly (P<0.05) smaller granules than other starches, therefore it gives pastes and gels with unique texture and rheological properties.

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 3 % rice starch level i.e. 6.50 and the highest scores for spreadability was observed in T-2 with 5 % rice starch level i.e. 7.55. The taste that stays in consumer's mouth after eating spent hen meat spread or other food products is after taste. 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 7 % rice starch level were having values 6.90 and 7.02 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 (3% rice starch level) i.e. 6.57. Highest overall acceptability scores were observed for T-2 (5% rice starch level) was 7.50. The spent hen meat spread incorporated with rice starch at 5% level showed the significantly (P<0.05) higher scores for all the parameters as compared to other treatment and control products.

Table 2: Sensory evaluation of spent hen meat spread incorporated with different levels of rice starch (Mean±SE)*

Parameters	**Sensory analysis**			
	Control	**T_1 (3% rice starch)**	**T_2 (5% rice starch)**	**T_3 (7% rice starch)**
Color/appearance	6.79±0.05^a	6.55±0.13^a	7.57±0.09^c	7.00±0.11^b
Flavour	6.86±0.06^b	6.55±0.13^a	7.55±0.08^c	7.07±0.11^b
Texture	6.90±0.06^b	6.55±0.10^a	7.52±0.09^c	7.05±0.13^b
Spreadability	6.90±0.06^b	6.50±0.01^a	7.55±0.08^c	7.00±0.10^b
After taste	6.86±0.07^b	6.52±0.12^a	7.52±0.08^c	7.05±0.11^b
Adhesivebility	6.90±0.05^b	6.60±0.09^a	7.55±0.09^c	7.02±0.09^b
Overall acceptability	6.90±0.07^b	6.57±0.10^a	7.62±0.08^c	7.00±0.10^b

n=21, C= Control; T-1= 3% rice starch; T-2= 5% rice starch; T-3= 7 % **rice** *starch. (Mean±SE)* with different superscripts in lower case in a raw differ significantly (P ≤0.05).*

Instrumental Colour Profile of Spent Hen Meat Spread Incorporated with Different Levels of Rice 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 rice starch. Lightness (L*) is related to the degree of clarity, indicating whether the colors are bright or dark. Lightness values of SHMS increased significantly (P<0.05) with increase in level of rice starch. Lowest (lightness) values were observed in the control, while the highest values for T-3, which shows that incorporation of rice starch resulted in lighter colored meat spread, which might be due to the white colored flour incorporation. Baardseth *et al* (1992); Vickery and Rodgers *et al* (2002a, 2002b); Dzieszuk *et al* (2005) and Liu *et al* (2008) also observed that addition of rice starch causes an increase in the lightness values, which might be due to retention of higher amount of water in the products.

Redness (*a**) values were decreased significantly (P<0.05) with the addition of rice starch, the higher the level of rice starch, the lower the redness values. Zhang *et al* (2013) showed that the addition of cassava starch (3, 6 or 9 %) resulted in increased L* values and a reduction of a* and b* values in surimi. The authors explained that adding cassava starch resulted in changes in the gel transparency and that the alteration in the a* value could have been related to myoglobin denaturation and gelatinization.

Yellowness (*b**) decreased significantly (P<0.05) from 17.67 to 12.61 with the increase in incorporation level of rice starch. In a study, Muthia *et al* (2010) added different flours such as tapioca, wheat and rice flours to duck sausage and found significant differences in instrumental colour values of products. The sausages incorporated with tapioca flour showed significantly (P<0.05) higher a∗ value in comparison to other flours, significantly (P<0.05) lower b∗ value than that of the rice sample, and a greater b∗ value than that of sago. Higher a* values indicate a redder color and lower values indicate a greener color; whereas, higher b* values indicate yellowness and lower b* values indicate a bluer color (Ramos and Gomide 2007).

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

Parameters	**Instrumental color profile**			
	Control	**T_1 (3% Rice Starch)**	**T_2 (5% Rice Starch)**	**T_3 (7% Rice Starch)**
Lightness	48.48 ± 0.36^{a}	49.91 ± 0.16^{b}	51.22 ± 0.17^{c}	53.39 ± 0.41^{d}
Redness (a*)	5.28 ± 0.01^{c}	5.13 ± 0.01^{bc}	4.91 ± 0.03^{b}	3.54 ± 0.19^{a}
Yellowness (b*)	17.67 ± 0.31^{c}	16.32 ± 0.14^{b}	14.03 ± 0.26^{c}	12.61 ± 0.32^{a}
Hue	0.06 ± 0.00^{a}	0.06 ± 0.00^{a}	0.049 ± 0.00^{a}	0.06 ± 0.00^{a}
Chrome	18.44 ± 0.92^{a}	17.11 ± 0.33^{c}	14.86 ± 0.25^{c}	13.10 ± 0.14^{b}

*n=6; C= Control; T-1= 3% rice starch; T-2= 5% rice starch; T-3= 7 % rice starch. *Mean±S.E. with different superscripts differ significantly (P<0.05).*

Physico-Chemical Properties and Proximate Composition of Spent Hen Meat Spread Incorporated With Different Levels Of Rice 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 rice 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 rice starch. The pH values of T-1, T-2 and T-3 was significantly (P<0.05) lower than the control. As the starch level increased in meat spread from 3 to 7 %, pH values were decreased. Arya *et al* (2019) also reported the lower pH (6.38) for the meat spread incorporated with 2% rice starch. Cooking yield followed increasing trend with the increase in the incorporation level of rice starch and the values were significantly (P<0.05) higher in the treatment product *i.e.* from 90.58 to 92.43%. Gao *et al* (2014) found that the addition of glutinous rice flour and corn starch significantly increased the cooking yield of meat patties. Ali *et al* (2011) also reported that the incorporation of cereal flours increased the cooking yield of patties prepared from pork and beef.

The moisture content of the spent hen chicken meat spread increased significantly (P<0.05) with increasing level of rice starch in the formulation. It could be due to the more water binding property of starchy flour. Eliasson (2006) also reported that native and modified starches are often used in the food industry as a binding, foam stabilizing and water binding agents. Martin *et al* (2000) also observed that 5% rice starch incorporation in pork batter significantly improved the moisture retention. Pereira *et al* (2016) also showed that emulsion-type meat products incorporated with starch-based ingredients tend to have more moisture content as compared to the control product. Protein values showed a significantly (P<0.05) decreasing trend with increase in the level of incorporation of rice starch. The values were found lower in treated products than control due to addition of carbohydrate rich flour. In comparison to the present study, higher percentage of protein content in spread was reported by Pandey *et al* (2016), they found 17.8% protein content in a product containing 65% lean meat.

The fat and ash content showed a non-significantly (P>0.05) decreasing trend among all the treatment products due to the incorporation of rice 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%). Moisture-protein ratios increased significantly (P<0.05) with increased in rice 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.

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

Parameters	Control	T_1 (3% rice starch)	T_2 (5% rice starch)	T_3 (7% rice starch)
	Physico-chemical properties			
pH	6.43±0.01[d]	6.41 ±0.01[c]	6.34±0.01[b]	6.28±0.01[a]
Cooking Yield (%)	90.16±0.34[a]	90.58±0.19[b]	91.53±0.10[c]	92.43±0.13[d]
	Proximate composition			
Moisture (%)	76.15±0.09[a]	77.11±0.13[ab]	77.89±0.21[bc]	78.34±0.19[c]
Protein (%)	12.11±0.12[c]	11.91±0.09[b]	11.57±0.08[ab]	10.82±0.07[a]
Fat (%)	6.39±0.07	6.31±0.04	6.25±0.07	6.19±0.07
Ash (%)	2.29±0.04	2.28±0.02	2.25±0.07	2.23±0.04
Moisture: Protein	6.29±0.09[a]	6.47±0.13[b]	6.73±0.21[b]	7.24±0.10[c]

*n=6; C= Control; T-1= 3% rice starch; T-2= 5% rice starch; T-3= 7% rice starch. *Mean±S.E. with different superscripts differ significantly (P<0.05).*

Conclusion

On basis of analysis of sensory parameters, instrumental colour profile, physico-chemical properties and proximate composition of control and treatment products, spent hen meat spread incorporated with rice starch at 5% level was found best for the preparation of excellent quality product.

Conflict of Interests

There is no conflict of interest.

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