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Optimization of Level of Incorporation of Different Dietary Fiber in the Development of Spent Hen Meat Snack Sticks

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ABSTRACT

The study was conducted from October to December, 2021 in the Department of Livestock Products Technology, College of Veterinary Science, Jabalpur, Madhya Pradesh, India to prepare spent hen meat snack sticks (SHSS) by partially replacing rice flour (RF) from the product formulation with healthy, dietary fiber rich oat, finger millet and amaranth flours (OF, FMF and AF) at different levels. Four batches of SHSS were prepared by substituting RF with different levels of OF, FMF and AF each at 0%, 5%, 10% and 15%. The optimum level of incorporation of dietary fiber from each set of products was standardized based on sensory evaluation of SHSS for various attributes. A combination of steaming, drying and frying (170°C for 45 sec) was found to be the most suitable cooking method for SHSS. Substitution of RF with 15% OF resulted in a significant decrease in flavour, crispness, and overall acceptability of the snacks while lower levels did not affect the sensorial attributes. FMF at 5% level did not alter the sensory attributes while at higher levels of replacement a significant decrease in color, flavor, crispness, and overall acceptability scores were noted. Higher levels of AF (15%) significantly improved flavour and overall acceptability of SHSS. The study clearly revealed that OF (10%), FMF (5%) and AF (15%) can be used efficiently for substitution of RF in the formulation of healthier and sensorially acceptable products. Snacks crafted with spent hen meat and dietary fiber will enhance the nutritional value especially with respect to amino acids, flavour, taste and technological functionality.

KEYWORDS: Dietary fibre, spent hen, meat snacks

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1. INTRODUCTION

The number of spent chickens has risen in tandem with the rapid growth of layer production. The meat of these birds is often considered as a waste or byproduct of commercial egg production and causes a disposal concern due to the abundance of connective tissues (Abe et al., 1996) and cross linkages with poor functional properties (Kumar et al., 2021). Despite being treated as waste, they are rich in animal protein and fat, and hence are suitable biomolecules for developing value-added products. Efficient utilization of spent hen meat, an inexpensive source of high-quality protein in foods can revolutionize meat industry by standardizing appropriate and cost-effective technology for processing underutilized meat into appealing and commercially feasible value-added meat products, that are palatable and economically viable (Jin et al., 2007). Development of communited meat products using this valuable protein source offers a promising avenue for their profitable disposal (Sabikun et al., 2021).

Snack are ready-to-eat/ prepare convenient food items eaten for the purpose of refreshment and short-term energy. The demand of snack foods is increasing day by day due to urbanization, changes in socio-economic conditions such as increasing working women etc. However, most snack foods usually evoke negative images and are recognized as unhealthy with low nutritional value and high energy density (Cakmak et al., 2016). Snacks are high in carbohydrates and minerals but low in good quality protein. Their nutritive and functional value can be enhanced by incorporating animal protein such as spent hen meat which has a favorable nutritional value in terms of total protein content, good quality amino acids, minerals, vitamins and less cholesterol (Anonymous, 2014) as well as lower price.

Meat products are rich in fat, added salts however are a poor source of complex carbohydrates such as dietary fiber. Diets rich in fiber are associated with the prevention, reduction, and treatment of some diseases, such as diverticular and coronary heart diseases (Hartley et al., 2016), constipation, irritable colon, colon cancer and diabetes (Wendy et al., 2017). Consumers of the modern era demand convenient foods but at the same time are highly conscious about their well-being and nutrition and thus there is a rising apprehension over nutritional diseases of affluence. Hence, inclusion of dietary fiber with potential health benefits in diets has been emphasized and is a promising way to improve product functionality. Apart from physiological benefits, dietary fiber serves to meet technological and functional properties in the development of convenient, nutritious, and healthier ready-to-eat meat-based snacks (Tomar et al., 2023). Designing and development of spent hen meat incorporated snack products can effectively prevent protein malnutrition related cases very much evident in children while incorporation of dietary fiber would improve their functionality (Choubey et al., 2024).

The market for snack foods with purposes is progressively expanding due to increased concern about health and healthy diet (Kuipers et al., 2011). Hence, spent hen meat incorporated snack products along with added dietary fiber may be a great option for altering nutritive value particularly high value animal protein and production of economic products. Further snacks can be easily made by small scale entrepreneurs and women's cooperatives of semi-urban and rural origin without much investment, the extended shelf of such products offers the advantage of limitless marketing opportunities without the requirement of cold storage (Choubey et al., 2024). Producing or adapting snack food preparations along these lines could be a good choice for persons suffering from severe nutritional crisis. Hence, the present study was conducted with an objective to develop economic, healthy and convenient meat snacks containing protein, fibre and fat using simple technologies that can be easily taken up entrepreneurs for production at increased scales.

2. MATERIALS AND METHODS

2.1. Standardization of processing conditions and formulation for development of spent hen meat snack sticks

The study was conducted in the month of October–December, 2021. Frozen deboned lean spent hen meat minced twice through 6 mm grinder plate of stainless-steel meat mincer (Sirman S.P.A.). Control SHSS were prepared as per the basic formulation mentioned in table 1. Minced chicken meat was blended with common salt, baking soda and half of the chilled water in a food mixer for 1 min, followed by mixing of spice mix and condiments. Rice flour (RF) (35%) was added to the batter and mixed again for 1–2 min for obtaining the SHSS. Thereafter, the dough was extruded by domestic hand extruder. Extruded SHSS were cut into pieces (around 4–5 cm) and subjected to further processing.

2.2. Standardization of cooking method for SHSS

Three batches of extruded SHSS were prepared as per standardized formulation detailed in table 1 and subjected to different cooking methods. First batch of extruded product was subjected to direct frying (DF) in refined oil heated to 170°C on induction stove. The snacks were taken out after they puffed properly on a tissue paper to remove excess oil. The second batch of extruded SHSS were subjected to drying + frying method (D+F) for cooking. The product was dried in a pre-heated hot air oven (70±2°C) for a period of 15 h and then fried in refined oil (170°C) till the product puffed properly. The last batch of extruded product was

Table 1: Basic formulation for preparation of spent hen meat snack sticks

Ingredients	Percentage (w/w)
Meat	50
Rice flour	35
Spices mix	3
Condiments	3
Salt	2.5
Baking soda	0.5
Oil	6

subjected to steaming + drying + frying (S+D+F) method of cooking. Product was steam cooked for 30 min then dried for 10±2 h in pre-heated hot air oven (70±2°C) followed by deep fat frying (170°C). The snacks prepared by different cooking techniques were evaluated further for various sensory properties on 8-point hedonic scale (Keeton, 1983). The most suitable method of cooking was selected based on sensory evaluation.

2.3. Standardization of cooking time for SHSS

Pre-cooked SHSS were subjected to frying for different time periods i.e. 30 sec, 45 sec and 60 sec. The developed products were evaluated for the sensory characteristics following 8-point hedonic scale (Keeton, 1983). Based on sensory evaluation, the optimum cooking time was selected.

2.4. Standardization of level of antioxidant DF's in extruded snacks

Four different batches of SHSS were prepared as per the formulation detailed in table 2 and procedure detailed earlier by substituting RF with OF. Similarly, four batches each of SHSS were prepared by substituting RF with different levels of finger millet flour (FMF) (0, 5%, 10% and 15%) and amaranth flour (AF) (0, 5%, 10% and 15%). The cooked products were subjected to sensory evaluation for selection of the optimum level of OF, FMF and AF incorporation. The first batch of SHSS was prepared by replacing RF with OF at the level of 0, 5, 10 and 15%, the second and third batches were prepared by replacing RF with FMF at similar levels.

Table 2: Formulation of SHSS with different levels of antioxidant dietary fibers

Ingredients	Control (%)	T_1 (%)	T_2 (%)	T_3 (%)
Minced meat	50	50	50	50
Salt	2.5	2.5	2.5	2.5
Spices	3	3	3	3
Baking soda	0.5	0.5	0.5	0.5
Condiments	3	3	3	3
Rice flour	35	30	25	20
Oat flour/ Finger millet flour/ Amaranth flour	0	5	10	15
Oil	6	6	6	6

2.5. Sensory evaluation

A seven-member panel of judges consisting of teachers and postgraduate students of Veterinary College, Jabalpur evaluated the samples for the sensory attributes of colour and appearance, crispness, flavour, meat flavour intensity (MFI), and overall acceptability (OA) using 8-point descriptive scale (Keeton, 1983), following all steps of a sensory evaluation test, where 8=excellent and 1=extremely poor. The test samples were presented to the panelists after assigning the suitable codes.

2.6. Statistical analysis

Data was analyzed statistically by using IBM SPSS Statistics software (Version 20.0 for Windows; IBM SPSS Inc, Chicago, 111, USA) as per standard methods (Snedecor and Cochran, 2007). The average values were reported along with standard deviation. Statistical significance was estimated at 5% (p<0.05).

3. RESULTS AND DISCUSSION

3.1. Standardization of cooking method for SHSS

The results of the sensory evaluation of SHSS for standardization of cooking method has been presented in Table 3. Perusal of the table revealed that colour and appearance (CA) the very first attribute to be considered by consumers when choosing a product rated good to fair for all treatments. Snacks cooked by different cooking methods did not vary significantly in terms of CA however, highest

Table 3: Standardization of cooking method for SHSS (Mean±SE)

Parameters	T_1	T_2	T_3
Colour and appearance (CA)	5.93^{a}± 0.10	6.00^{a}± 0.26	6.05^{a}± 0.21
Crispness	5.10^{b}± 0.47	6.25^{ab}± 0.67	6.98^{a}± 0.30
Flavour	6.09^{a}± 0.10	6.14^{a}± 0.11	6.18^{a}± 0.29
Meat flavour intensity	5.70^{a}± 0.37	5.76^{a}± 0.44	5.80^{a}± 0.18
Overall acceptability	5.00^{c}± 0.20	5.94^{b}± 0.10	6.50^{a}± 0.20

Mean with different superscript in a same row differ significantly (p<0.05); n=21; T_1: Direct frying (DF); T_2: Drying+Frying (D+F); T_3: Steaming+Drying+Frying (S+D+F)

CA score was observed in T_3. The non-significant difference in scores may be due to the uniform golden brown colour of the products obtained because of Maillard reaction. Poodari (2017), reported similar results for CA in chicken meat *kachori* prepared by using three different cooking methods.

Crispness is a salient textural characteristic for most fresh dry cereal and starch-based snack food products and is critical textural attribute. Higher values of crispness were observed in T_3 followed by T_2 and T_1. Scores of T_3 and T_2 were comparable but varied significantly ($p<0.05$) from T_1 while the scores obtained for T_2 and T_1 were comparable. Lower crispness of T_1 may be due to higher moisture content in it which was not subjected to any prior processing technique for moisture removal as compared to T_2 and T_3 which were dried prior to frying, thereby resulting in lower moisture content and higher crispness. The interior of T_1 had a soggy texture even after frying.

Flavour, defined as a complex group of sensations comprising olfactory (odour), taste and other chemical sensations (Lawless and Heymann, 1998) showed no significant difference between the treatments and were rated as good for all batches. Non-significant difference in scores may be attributed to the formulation and application of frying either directly or as a part of the cooking method. Flavour develops by a combination of reactions and compounds absorbed by the frying oil. The main factors affecting the changes in color and flavour during the process are the oil type, storage and thermal changes, interfacial tension between the oil and the product, temperature and length of frying, moisture content, size and characteristics of food surface and pre-frying treatments (Fellows, 2006). Moreover, frying gives a unique flavour to the product, simultaneous mass and heat transfer by hot oil modifies the food surface, forming a crust over the fried food that preserves flavour and thus preferred for snack items.

No significant difference in MFI (meat flavor intensity) was observed between products cooked by different methods due to same formulation. Fat and fatty acids are responsible for the characteristic meat flavour of a product. These fats undergo changes during processing like mixing, cooking, drying, frying etc. thereby, diminishes the characteristic flavour of meat in the products. Similar results were reported by Nayar (2012), who observed non-significant difference in goat meat cubes cooked by steaming followed by hot air oven drying and microwave drying methods.

These scores reflect the average of CA, flavour, crispness and other sensory attributes and observed highly significant ($p<0.05$) difference amongst the three different cooking methods. SHSS prepared by combination of S+D+F (T_3) had significantly ($p<0.05$) higher OA scores followed by T_2 and T_1. The lowest OA scores in T_1 can be correlated to the lower crispness of snacks prepared by direct frying method as these attributes majorly reflect the crunchiness of snack products. Chand (2011) prepared ready to fry meat snacks via steaming, drying and frying and observed a higher OA of these products as compared to microwaved snacks.

As a result of the sensory evaluation T_3 i.e. combination of steaming, drying and frying was selected as the most suitable method for cooking of SHSS for further study.

3.2. Standardization of frying time

A combination of S+D+F was used for preparation of SHSS. The steamed and dried product was fried in hot oil (170°C) for different time periods i.e. 30 seconds, 45 seconds and 60 seconds and subjected to sensory evaluation for standardization of optimum frying time.

Colour is a significant quality parameter of fried snacks concerning consumer understanding and frequently is the foundation for their chosen fried snacks. Perusal of Table 4 revealed higher CA scores in T_2 followed by T_1 and T_3. The CA scores of T_1 and T_2 varied significantly ($p<0.05$) from T_3 while there was no significant difference between the scores of T_1 and T_2. Lower values noted in T_3 was due to the excessively dark colouration of SHSS due to longer frying duration which was not liked by the panelists. Increased frying temperature during the deep-frying process initiates nonenzymatic browning reactions that affect product's colour (Cruz et al., 2018). Similar results have been observed by Kantale et al. (2019) in chicken meat *samosas* fried at different time temperature combinations. Jumayi and Darwish (2021) recorded higher colour scores in barley soyabean chips fried for 60 sec as compared to 90 and 120 seconds.

Crispness score was highest in T_3 while T_1 observed significantly ($p<0.05$) lower values as compared with T_2

Table 4: Standardization of frying time for spent hen meat snack sticks

Parameters	T_1	T_2	T_3
Appearance and color	$5.97^a \pm 0.41$	$6.02^a \pm 0.39$	$5.30^b \pm 0.44$
Crispness	$5.70^b \pm 0.50$	$6.95^a \pm 0.33$	$7.00^a \pm 0.30$
Flavour	$6.03^a \pm 0.37$	$6.11^a \pm 0.18$	$4.90^b \pm 0.28$
Meat flavour intensity	$5.70^a \pm 0.38$	$5.80^a \pm 0.24$	$4.60^b \pm 0.41$
Overall acceptability	$5.62^b \pm 0.30$	$6.75^a \pm 0.18$	$5.40^b \pm 0.21$

T_1: 30 seconds; T_2: 45 seconds; T_3: 60 seconds; Mean with different superscript in a same row-wise differ significantly ($p<0.05$), n=21 and T_3. Increased crispness of T_3 showed to be related with increased frying time and the porous structures accompanied with losing moisture that plays a significant role in crispness (Ziaiifar et al., 2010). Similarly higher score for crispness was recorded in battered snacks fried for 1 min (Primo-Martín and van Deventer, 2011). An increase in crispness and taste followed by a decrease was shown with the increase in frying temperature and time in *falafel* prepared by Fikry et al. (2021).

T_2 scored significantly higher ($p<0.05$) for flavour followed by T_1 and T_3. The significantly lower ($p<0.05$) flavour in T_3 may be attributed to the development of burnt flavour due to extended frying time. The sensory quality represented in flavour is a significant attribute in the manufacturing of fried foods and is related to processing conditions and variables such as frying time, temperature and moisture content (Bahram Parvar et al., 2014). Similarly, decline in flavour scores have been recorded by Kantale et al. (2019) in fried chicken meat *samosas* with increase in frying time.

MFI scores observed was comparable to that of flavour scores and were highest in T_2 followed by T_1 and T_3. The MFI scores of T_3 was significantly ($p<0.05$) lower than T_1 and T_2 which may be attributed to the burnt flavour masking meat flavour in SHSS. Moreover, frying for longer duration could have resulted in accumulation of undesirable substances of food particles and oxidative compounds of oil resulting in lower MFI (Ugwu et al., 2015).

T_2 scored significantly ($p<0.05$) higher OA as compared to T_1 and T_3. Lower scores in T_1 may be due to low crispness scores while T_3 obtained lower scores due to burnt flavour development due to extended frying time. T_2 obtained higher scores for flavour, MFI, crispness and thereby higher acceptability by the panelists. Similar results were obtained by Jumayi and Darwish (2021) in barley soyabean chips fried for higher durations. Fikry et al. (2021) also observed lower overall preference scores with increase in frying temperature and time for *falafel*.

Based on the results of sensory evaluation T_2 i.e. 45 seconds was chosen as the optimum time for frying of SHSS for further experiments.

3.3. Optimization of the level of incorporation of oat flour in SHSS

SHSS formulated with rice flour (Control) and different levels of OF (T_1-5%, T_2-10% and T_3-15%) were processed by combination of S+D+F and thereafter subjected to sensory evaluation for selection of optimum level of incorporation of OF. The results of sensory evaluation of SHSS developed are presented in Table 5.

Critical appraisal of the results revealed no significant difference among the treatments. However, higher CA scores were recorded in control followed by T_1, T_2 and T_3. The non-significant difference in CA scores may be related to the uniformity in processing conditions applied to SHSS which led to the development of golden brown colour because of maillard reaction. Chand, 2011 reported that level of meat and type of flour used indicated no significant difference on the appearance of fried chicken snacks.

Table 5: Comparison of different levels of oat flour (OF) incorporation on the sensory attributes of SHSS (Mean±SE)

Parameters	Control	T_1	T_2	T_3
Appearance and color	$7.00^{a}\pm 0.17$	$6.95^{a}\pm 0.18$	$6.92^{a}\pm 0.28$	$6.90^{a}\pm 0.42$
Flavour	$6.75^{a}\pm 0.30$	$6.55^{ab}\pm 0.55$	$6.67^{a}\pm 0.17$	$5.63^{b}\pm 0.21$
Crispness	$7.02^{a}\pm 0.10$	$7.00^{a}\pm 0.10$	$6.89^{ab}\pm 0.18$	$6.32^{b}\pm 0.20$
Meat flavour intensity	$5.87^{a}\pm 0.12$	$5.85^{a}\pm 0.12$	$5.64^{ab}\pm 0.15$	$5.00^{b}\pm 0.15$
Overall acceptability	$6.75^{a}\pm 0.24$	$6.55^{a}\pm 0.14$	$6.53^{a}\pm 0.13$	$5.00^{b}\pm 0.12$

Mean with different superscript in a same row differ significantly ($p<0.05$), n=21, Control: 35% RF; T_1: 5% OF+30% RF; T_2: 10% OF+25% RF; T_3: 15% OF+20% RF

Flavour scores ranged from moderately desirable to slightly desirable. Control and T_2 had significantly ($p<0.05$) higher scores as compared to T_3 however, the scores of T_1 were comparable with other groups. With higher levels of substitution of RF with OF a decreasing trend in flavour scores were noted. Highest scores were observed for control followed by T_2, T_1. The results are in consonance with that of Rohani et al. (2010) who noted significant decrease in flavor and texture scores of instant fish crackers enriched with higher levels of oat fibre.

A significant difference ($p<0.05$) in crispness among different treatments were noted although control and T_1 did not vary significantly. Crispness score was maximum for control and minimum for T_3. With increase in levels of OF substituting RF in treatment groups, a significant ($p<0.05$) decrease in scores were noted which may be correlated to higher levels of DF in OF. Crispness is typically a textural parameter for fried products and is dependent on the ingredients, formulation, and processes (Chang et al., 1990). Similar results have been noted by Kale (2009) in chicken snack sticks incorporated with different levels of OF. Similarly, Prince et al. (1994) reported decrease in crispness (instrumental) of rice soya crackers with increase in percentage of soya and decrease in percentage of rice flour.

MFI scores did not observe a significant difference among control and T_1, however both varied significantly ($p<0.05$)

from T_2 and T_3. Control and T_3 (15% OF) recorded the maximum and minimum scores respectively. The scores of T_2 and T_3 were comparable with each other. The results revealed that addition of OF at lower levels preserved the natural flavour of meat however, higher levels of incorporation masked the intensity of meat flavour.

Highest OA score was recorded in control and among treatments T_1 had the highest acceptability, followed by T_2 and T_3. The OA score of control, T_1 and T_2 were comparable but was significantly (p<0.05) higher than T_3. The higher OA of T_1 and T_2 amongst treatments may be related to its higher crispness and flavour scores which are key features of snack-based products while lower scores in T_3 may be attributed to higher levels of OF in the snacks. The results are analogous to Garcia et al. (2002) who reported decrease in OA of meat cookies incorporated with high levels of DFs. Rohani et al. (2010) reported that oat fibres at high levels gave a dry mouth feel and lower texture scores that decreased the OA of instant fish crackers.

Although T_1 and T_2 had comparable OA, T_2 (10% OF) was selected as the optimum level of incorporation in SHSS for further study due to its higher flavour and higher antioxidant dietary fibre content.

3.4. Optimization of the level of incorporation of FMF in SHSS

Perusal of Table 6 revealed significant (p<0.05) decrease in CA of products with higher levels of incorporation of FMF. Control SHSS observed the highest CA scores and varied significantly (p<0.05) with T_2 and T_3, while the scores were comparable with T_1. Lower CA acceptability of T_2 and T_3 by the sensory panelists may be attributed to the brown colour of FMF which caused darkening of the product color. Similarly, Naveena et al. (2006) stated that there was no negative effect of ragi flour addition (upto 5%), on the sensory attributes of chicken patties. Similarly, Kaur et al. (2016) noted significantly (p<0.05) darker color, lower appearance values and instrumental lightness (L^*) values in fish cutlets prepared from ragi flour as compared to their counterparts.

Table 6: Comparison of different levels of finger millet flour (FMF) incorporation on the sensory attributes of SHSS (Mean±SE)

Parameters	Control	T_1	T_2	T_3
Appearance and color	6.95^{a}± 0.09	6.88^{a}± 0.11	5.40^{b}± 0.40	4.65^{c}± 0.21
Flavour	6.63^{a}± 0.09	6.56^{a}± 0.24	6.30^{a}± 0.34	5.65^{b}± 0.13
Crispness	7.11^{a}± 0.16	7.08^{ab}± 0.12	6.71^{ab}± 0.15	6.23^{b}± 0.25
Meat flavour intensity	5.92^{a}± 0.17	5.85^{a}± 0.11	5.55^{ab}± 0.37	4.95^{b}± 0.32
Overall acceptability	6.80^{a}± 0.16	6.62^{a}± 0.11	6.05^{b}± 0.08	5.75^{b}± 0.12

Control: 35% RF; T_1: 5% FMF+30% RF; T_2: 10% FMF+25% RF; T_3: 15% FMF+20% RF; Mean with different superscript in a same row differ significantly (p<0.05), n=21

Flavour scores followed a decreasing trend with increase in levels of FMF. T_1 had significantly (p<0.05) higher scores as compared to T_3 but was comparable with that of T_2. Flavour scores of control SHSS varied significantly (p<0.05) from T_3 but did not have a significant difference with T_1 and T_2. The decreased flavour score upon higher level of FMF incorporation in chevon patties were also reported by Kumar et al. (2016), which was attributed to the development of bitterness as a sequel of Maillard browning reactions.

The results of crispness did not vary significantly amongst SHSS incorporated with different levels of FMF although decrease in crispness scores were noted with increase in levels of FMF. Control SHSS recorded the highest scores for crispness and was significantly higher (p<0.05) than T_3 but comparable to T_1 and T_2. The decrease in crispness might be related to lower levels of rice flour and higher levels of FMF indicating that FMF at higher level affected the crispness property of SHSS. Similarly, Instant fish crackers enriched with different higher levels of dietary fibres were less crispy and required more force to break the pieces as indicated by their lower texture score and higher hardness values (Rohani et al., 2010).

There was no significant difference between the MFI scores of control, T_1 and T_2 T_3 had significantly (p<0.05) lower scores than control and T_1 while the scores were comparable to T_2. The results obtained in the present study were lower than those observed by Kale (2009) and Singh et al. (2002) due to the lower level of meat used in the formulation of SHSS.

Critical appraisal of results revealed highest OA scores in control followed by T_1, T_2 and T_3. The OA scores of control and T_1 did not show any significant difference but were significantly (p<0.05) higher than T_2 and T_3. The general trend was that OA scores decreased with increased levels of FMF and lower levels of RF which reduced the crispness and flavour scores of SHSS. Naveena et al. (2006) reported that OA was optimum with incorporation of ragi flour upto 5% level in chicken patties and at higher levels the sensory score decreased which agrees with the present study.

Hence, it was concluded that 5% FMF level was found to be optimum and hence chosen for preparing SHSS as compared to 10% and 15% FMF for further study.

3.5. Optimization of the level of incorporation of AF in SHSS

Analysis of data from table 7 revealed that CA score did

Table 7: Comparison of different levels of amaranth flour (AF) incorporation on the sensory attributes of SHSS (Mean±SE)

Parameters	Control	T_1	T_2	T_3
Appearance and color	6.98^{a}± 0.14	6.87^{a}± 0.18	6.90^{a}± 0.29	6.91^{a}± 0.21
Flavour	6.71^{b}± 0.11	6.78^{b}± 0.13	7.10^{ab}± 0.13	7.15^{a}± 0.10
Crispness	7.14± 0.12	7.04± 0.23	7.00± 0.08	6.96± 0.15
Meat flavour intensity	5.97^{a}± 0.12	5.95^{a}± 0.11	5.90^{a}± 0.14	5.81^{a}± 0.10
Overall acceptability	6.85^{ab}± 0.20	6.59^{b}± 0.11	6.76^{ab}± 0.12	6.95^{a}± 0.21

Control: 35% RF; T_1: 5% AF+30% RF; T_2: 10% AF+25% RF; T_3: 15% AF+20% RF; Mean with different superscript in same row differ significantly (p<0.05), n=21

not vary significantly (p>0.05) between the four batches of SHSS. However, among treated samples T_3 batch obtained highest score and T_1 showed lowest score. Control products had marginally higher CA as compared to the treatment groups. The non-significant difference in CA scores amongst the different batches indicated that addition of AF at different levels as a replacement of RF did not affect the appearance of the product. Peska et al. (2016) observed that addition of AF did not significantly change the sensory attributes of regular corn snacks.

Sensory panelists rated AF incorporated SHSS higher than the control for flavour. The data revealed that with increase in level of incorporation of AF an increase in flavor scores were noted and the mean values increased significantly (p<0.05) at 15% replacement. Higher flavour scores were observed for SHSS incorporated with AF which might be due to the nutty flavour of AF which was liked by the panelists. The results were in accordance with that of Petrova (2021) who reported AF incorporated fish farce had nutty flavour that was preferred over by sensory analysts.

AF incorporation in SHSS formulation had non-significant effect on the crispness although the scores decreased with increasing levels of replacement. The lower scores of treatments could be due to increased levels of DF in AF. However, the results indicated that replacement of RF with AF upto 15% did not have any negative impact on the crispness of SHSS. Gebreil et al., 2020 recorded similar pattern of scores in crackers incorporated with different levels of AF. Similarly, Teixeira et al., 2020 replaced wheat flour with AF in tilapia fish balls without any significant effect on texture.

MFI did not differ significantly (p<0.05) amongst different batches of SHSS but panelist scores decreased with increase in AF content. The lower scores may be attributed to the stronger masking effect of amaranth over meat.

The OA scores of sensory panelists rated T_3 as highest which differed significantly (p<0.05) from other products. This might be attributed to the flavour, crispness and MFI which was perceived strongly without affecting the snack qualities. Flavour, crispness and appearance of a product dramatically influence the overall perception and palatability of products. Peska et al. (2016) reported that AF did not change most of the sensory attributes critically appearance and texture and hence, would serve as the most appropriate additive for corn snacks enrichment. Regarding sensory appreciation, bakery products incorporating amaranth have been accepted at levels upto 15–25 g 100 g^{-1} (Solarov et al., 2008).

Results of the study indicated that replacement of RF with AF in SHSS improved the flavour of the products but decreased the crispness which may be attributed to higher fibre content of AF. Hence, based on the sensory evaluation, 15% AF was selected for incorporation in SHSS.

4. CONCLUSION

SHSS prepared by different cooking techniques were evaluated for various sensory properties on 8-point hedonic scale. The most suitable cooking method and time were selected to be steaming+drying+frying and 45 seconds respectively. Based on the results of evaluating sensory attributes like appearance and color, flavour, crispiness, meat flavour intensity and overall acceptability, sensory evaluation 10% OF, 5% FMF and 15% AF level was selected as the optimum level of incorporation in development of shelf stable antioxidant dietary fibre enriched SHSS.

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