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Utilization of Cauliflower Stems and Leaves Powder in the Development of High Fibre Spent Hen Meat Cutlets

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ABSTRACT

The present study was envisaged to develop high fibre spent hen meat cutlets by utilizing stems and leaves powder of cauliflower (CLSP) at four different levels viz. Control-0%, T1-2%, T2-4% and T3-6%, by replacing lean meat in the basic formulation. The developed meat cutlets were analyzed for various physicochemical, proximate, instrumental colour, texture and sensory attributes. Moisture, cooking yield, ash and fibre content recorded a significant ($p<0.05$) increase whereas pH and fat content followed a significant ($p<0.05$) decreasing trend in CLSP incorporated spent hen meat cutlets. Dimensional parameters such as height expansion and length/breadth shrinkage improved significantly ($p<0.05$) in all the treatments containing CSLP compared to control. Color values viz. L* and b* values recorded a significant ($p<0.05$) increase whereas a* values followed the decreasing trend with increasing levels of CLSP in meat cutlets. CLSP incorporation resulted in significant ($p<0.05$) improvement in the textural profile of meat cutlets. The overall acceptability scores of spent hen meat cutlets decreased significantly ($p<0.05$) with the addition of CSLP at a 6% level as compared to the other two treatments and control, due to the masking of meat flavor by vegetable source. Thus, fibre fortified spent hen meat cutlets having good acceptability and high nutritive value could be prepared by utilizing cauliflower waste (stems and leaves powder) at a 4% level of lean meat replacement, as it is a good source of dietary fibre and beta-carotene.

Key words: *Cauliflower stems and leaves powder, Cutlets, Fibre enrichment, Physicochemical attributes, Sensory attributes*

INTRODUCTION

Meat from the spent birds is generally tough, dry, and has poor functional properties which limit its utilization and consumption among consumers. The rapid expansion of poultry farming resulted in the availability of huge stock of culled and spent hens to be culled at the end of their reproductive life. The meat obtained from these culled poultry is considered as the meat of poor quality and fetch a lower price in the market than broiler meat due to less juiciness and toughness due to high degrees of collagen cross-linkages. Further increased availability of broiler meat also reduced the consumer's preference for spent hen meat. The proper remunerative disposal of this meat poses a real problem to poultry farmers and the development of various value-added meat products with low price and high nutritive value by suitable technological interventions is considered an ideal solution for profitable utilization of the meat from spent hen (Kumar et al. 2012).

Snacks are ready-to-eat (RTE) or ready-to-prepare food products that are usually consumed in between meals for satisfying short-term hunger. This segment has witnessed phenomenal growth in production and accessibility to various population groups (Kumar et al. 2019). The demand for healthy food snacks is growing continuously. Cutlets are one of the most popular flat croquette snack items in Asian countries widely served in quick service restaurants and fast food outlets as a part of breakfast items (Singh et al. 2014a, b). Cutlets are traditionally cereal-based snacks and their nutritive value can be further enhanced by utilizing spent hen meat. Cutlets are low in dietary fat content which can be significantly improved by the incorporation of various fruits and vegetables rich in dietary fibers such as carrot powder in chicken cutlets (Singh et al. 2015a), oat powder in chevon cutlets (Singh et al. 2015b), gram flour in chicken cutlets (Ahlawat et al. 2012), etc. The addition of various natural fibre source resulted in improvement of physico-chemical, textural, and sensory attributes as well as lower cost of production of the cutlets.

Cauliflower, a cruciferous vegetable that belongs to the family *Brassicaceae*, is cultivated mainly in northeast regions (Chauhanet al. 2014) for its edible flower structures and stalks. Cauliflower leaves are rich in iron, dietary fibre, and beta-carotene and are considered highly beneficial for health due to the presence of certain bioactive compounds like glucosinolates and indole-3-carbinol, associated with the prevention of anemia, prostate cancer, cardiovascular diseases, and diabetes. Cauliflower leaves are a rich source of sulfur compounds- associated with the destruction of cancer stem cells (Guerrero et al. 2012), sulphoraphane compounds- associated with substantial improvement in kidney functioning and hypertension (Knektet al. 2002; Zhang and Hamauza 2004), and anthocyanins- effective in controlling diabetes and bacterial infections (Li et al. 2012). During the processing of cauliflower fruit such as curry in most Indian households, cauliflower stem and leaves surrounding fruits are removed and disposed of. The waste index of cauliflower is high and almost 70-80% of cauliflower waste (stems and leaves) does not find any significant commercial use. Dried cauliflower leaves are rich source of beta-carotene, Vitamin B5, Iron, copper, manganese, zinc, etc (Wani and Kaul2011). These parts are rich source of dietary fibre and various bioactive compounds such as carotene, flavonoids, etc. and could be an excellent source of dietary fibre and bioactive compounds in the development of meat products. This will ensure proper and efficient utilization of these underutilized leaves and stems of cauliflower and will improve the profitability of the meat industry.

The purpose of this study was to analyze the physico-chemical properties, proximate compositions, and sensory attributes of spent hen meat cutlets fortified with cauliflower stems and leaves powder.

MATERIALS AND METHODS

Preparation of cauliflower stems and leaves powder (CLSP): The raw materials (cauliflower stems and leaves) were procured from the local market of Ludhiana city. After washing and blanching for 3 minutes with water containing 2% salt, cauliflower stems and leaves were sliced and subsequently dried in a tray drier(Macro Scientific Works Pvt Ltd Delhi, India) at 65°Cto reduce moisture levels up to 12% or below. The dried stems and leaves were grounded (Inalsa grinder) into a fine powder and filtered through stainless steel sieve (80 mesh) before storage in low-density polyethylene pouches (100 gauge thickness) at room temperature for use in the preparation of meat cutlets.

Preparation of meat cutlets: Spent birds of 72 weeks of age were scientifically slaughtered and dressed as per the standard procedures in the slaughterhouse of the Department of Livestock Products Technology, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India. After proper inspection and chilling, birds were deboned manually and kept under frozen (-20°C) storage in LDPE pouches (100 gauge thickness) until further use. Frozen spent hen meat was partially thawed at refrigeration temperature (4±1°C), cut into small chunks, and minced through a 6 mm plate in a meat mincer (MADO Eskimo Mew 714, Spain). Minced meat was blended with shredded potatoes (10%), condiments (10%), refined oil (4%), refined wheat flour (2%), salt (1.50%), spices (2%), and red chillies (0.5%). The formulation of meat cutlet is summarized in Table 1. Four different meat cutlet formulations were prepared by incorporating different levels of cauliflower stems and leaves powder viz. 0% (control), 2.0 % (T1), 4.0% (T2) and 6.0% (T3) replacing lean meat. After blending all the ingredients in four different groups, the raw batter was stuffed in the moulds of 62×45×22 mm dimensions and cooked in a preheated hot air oven at 180°C for 12 minutes followed by shallow frying in refined oil at 180°C.After frying, meat cutlets were removed and gently blotted to remove excess surface oil with help of tissue paper. Fried meat cutlets were cooled down in a desiccator before packing in LDPE pouches and analyzed for various quality attributes.

Table 1. Formulation for preparation of spent hen meat cutlets

Ingredients (% w/w)	Control	T1 (2% CLSP)	T2 (4% CLSP)	T3 (6% CLSP)
Minced meat	70.0	68.0	66.0	64.0
Cauliflower stems and leaves powder (CSLP)	-	2.0	4.0	6.0
Shredded potato	10.0	10.0	10.0	10.0
Condiments	10.0	10.0	10.0	10.0
Refined oil	4.0	4.0	4.0	4.0
Refined wheat flour	2.0	2.0	2.0	2.0
Salt	1.50	1.50	1.50	1.50
Spice mix	2.0	2.0	2.0	2.0
Red chilli powder	0.5	0.5	0.5	0.5

CSLP: Cauliflower stems and leaves powder.

Physico-chemical analysis of spent hen meat cutlets: The pH of the spent hen meat cutlets was measured with a digital pH meter (SAB 5000, LABINDIA, Mumbai) as per the procedure of Keller et al. (1974). The cooking yield was calculated as a percentage of the difference in weight of cutlets before and after cooking. Dimensional parameters such as length/breadth shrinkage (%) and height expansion (%) were estimated as per the procedure of Verma et al. (2015a) with the help of vernier caliper at three different points. The percentage height expansion and diameter shrinkage were calculated as per the following formula:

Breadth/length shrinkage (%) =

$$\frac{\text{Breadth/length of raw cutlet} - \text{Breadth/length of cooked cutlets}}{\text{Breadth/length of raw cutlet}} \times 100$$

Height expansion (%) =

$$\frac{\text{Height of raw cutlet} - \text{Height of cooked cutlet}}{\text{Height of raw cutlet}} \times 100$$

Proximate analysis: The moisture (oven drying method), fat (Soxhlet extraction), protein (Kjeldahl distillation, N× 6.25), crude fibre and ash (muffle furnace) contents of CLSP and spent hen meat cutlets were estimated as per the standard procedures of the Association of Official Analytical Chemists (AOAC 2000). Total calories were estimated by following the Atwater value for carbohydrate (4 kcal/g), fat (9kcal/g), and protein (4.02 kcal/g).

Instrumental colour and textural profile: The colour profile was determined using Chroma Meter (CR-400 Konica Minolta, Osaka, Japan). The instrument was calibrated using white tile for measuring L*(lightness), a* (redness), and b*(yellowness) values. The textural profile (hardness, springiness, cohesiveness, chewiness, and gumminess) were analyzed by using an instrumental Texture Analyzer (TMS-PRO, Food Technology Corporation, Maries Road, Suite 120 Sterling, VA, USA) as per the method of Bourne (1978).

Sensory evaluation: Sensory evaluation of the developed cutlets was performed by 12 experienced panelists comprising faculty and post-graduate students of the department on the 8-point descriptive scale (8= extremely liked and 1= extremely disliked) for various sensory parameters like colour and appearance, flavor, juiciness, tenderness, and overall acceptability (Keeton1983). The panelists were seated in a room free of noise and odours and suitably illuminated with natural light. Samples were warmed and presented along with potable warm water to all the panelists in a coded manner.

Statistical analysis: Data was analyzed using software, statistical package for social sciences (SPSS 20.0), as per the standard methods. Experimental trials were replicated thrice with duplicate analysis for physicochemical and proximate parameters (n = 6),sensory attributes (n = 36, 12 members), and triplicate analysis for colour and textural profile (n = 9).Data obtained was subjected to statistical analysis for analysis of variance (ANOVA) and Duncan's multiple range test for comparing means at 5% level ($p<0.05$) of significance.

RESULTS AND DISCUSSION

Analysis of cauliflower stems and leaves powder (CSLP): The chemical composition of CSLP is depicted in Table 2. CSLP contains moisture % (11.53±0.37), fat% (1.66±0.15), protein% (1.57±0.23), ash % (11.53±0.07) and crude fibre % (45.20±0.62) respectively. Sharma and Prasad (2018) also reported CSLP as a rich source of minerals and crude fibre, thus could be utilized to overcome micronutrient deficiencies, especially in developing countries by food fortification. Buxet al. (2015) and Thilagam et al. (2011) also recorded higher minerals and crude fibre whereas lower fat content in CSLP. Buxet al. (2015) also reported cauliflower as a good source of dietary fibre which safeguards health by lowering blood sugar levels, clearing colon content, and decreasing hypercholesterolemia. The water activity (aw) and pH of CLSP were recorded as 0.48±0.07 and 4.75±0.05 respectively. The colour profile of CLSP was recorded using Lovibond Tintometer with L* value (68.50±0.38), a* value (-1.58±0.27), and b* value (36.72±0.72) respectively. The recorded L*, a*, and b* values might be due to the bright green colour and high beta-carotene content (43.11 mg/100g) in cauliflower stems and leaves powder (Pankaret al. 2018).

Table 2. Analysis of cauliflower stems and leaves powder (CSLP)

Parameters	
Moisture (%)	11.53±0.37
Fat (%)	1.66±0.15
Protein (%)	1.57±0.23
Ash (%)	11.53±0.07
Crude fibre (%)	45.20±0.62
Water activity (%)	0.48±0.07
pH	4.75±0.05
Instrumental colour	
L*	68.50±0.38
a*	-1.58±0.27
b*	36.72±0.72

Analysis of Spent Hen Meat Cutlets Incorporated with CSLP

Physico-chemical and proximate analysis: Physico-chemical and proximate parameters of spent hen meat cutlets incorporated with 2%, 4%, and 6% levels of cauliflower stem and leaves powder (CSLP)are presented in Table 3. The mean pH values of all the three treatments followed a significant (P<0.05) decreasing trend relative to control samples. This could be due to the acidic pH (4.75) of CSLP. A similar decrease in the pH values of guava powder incorporated in mutton nuggets and broccoli powder extract incorporated goat meat nuggets were observed by Verma et al. (2013) and Banerjee et al.(2012). Akhilesh et al. (2015) also reported a significant (P<0.05) decrease in the pH of chicken meatballs incorporated with green cabbage. The cooking yield increased significantly (P<0.05) with increased levels of CLPS incorporation. Lai et al. (2003) reported a substantial increase in viscosity of chicken nuggets by incorporating vegetable powders having higher dietary fibre content which ultimately reduces cooking losses. Similarly, the prevention of water loss during cooking might be attributed to the formation of a three-dimensional protein-starch stable gel structure (Verma et al. 2016). Results were also in accordance with the other scientific investigations on different meat products like pork patties, jerky, breakfast sausages, etc (Kumar et al. 2007; Kim et al. 2012; Lee et al. 2008).

The moisture content exhibited a significant (P<0.05) increase upon the incorporation of CSLP and the values for T2 and T3 were significantly (P<0.05) higher compared to T1 and control. This might be due to better moisture retention and improved water holding capacity of fibre content present in cauliflower stems and leaves powder. A similar trend was reported by Devatkal et al. (2004) and Werner et al. (2002) in buffalo meat loaves and pork sausages upon the incorporation of carrot powder. Singh et al. (2015b) and Akhilesh et al. (2015) observed a similar increase in moisture content of spent hen meat cutlets incorporated with carrot powder and chicken meatballs incorporated with green cabbage respectively. Fat content decreased significantly (P<0.05) whereas protein content recorded a non-significant decrease upon the incorporation of CLSP in spent hen meat cutlets. A decrease in fat content might be due to low fat in CLSP and higher moisture in treated groups. Similar trends have also been reported by Verma et al. (2015b) in jackfruit incorporated chevon patties and Akhilesh et al. (2015) in green cabbage incorporated chicken meatballs. Ash and crude fibre

Table 3. Physico-chemical and proximate parameters of spent hen meat cutlets incorporated with cauliflower stems and leaves powder (Mean ±S.E)*

Parameters	**Control**	**T1(2% CLSP)**	**T2 (4% CLSP)**	**T3 (6% CLSP)**
Cooked Cutlets				
pH	5.94±0.04c	5.71±0.03b	5.50±0.02a	5.43±0.0 a
Cooking yield (%)	85.29±0.31a	87.08±0.19b	91.67±0.33c	92.64±0.26c
Moisture (%)	55.75±0.54a	59.21±0.45a	60.68±0.63b	61.05±0.48b
Fat (%)	16.41±0.10d	15.32±0.18c	14.78±0.11b	14.18±0.12a
Protein (%)	11.45±0.22	11.34±0.18	11.26±0.32	11.07±0.19
Ash (%)	1.98±0.06[a]	2.27±0.08[b]	2.48±0.03[bc]	2.63±0.07[c]
Crude fibre (%)	0.32±0.02[a]	1.02±0.05[b]	1.82±0.09[c]	2.57±0.08[d]

(Mean±S.E)*n=6 Means with different superscripts differ significantly (P < 0.05) in a row.

increased significantly (P<0.05) in all the treatments compared to control due to higher mineral and fibre content in CSLP. Sharma and Prasad (2018) also reported CSLP as a rich source of minerals and crude fibre, thus could be utilized in food fortification to overcome micronutrient deficiencies, especially in developing countries. Kumar et al. (2015) observed a significant (P<0.05) increase in fibre content of chevon patties added with finger millet flour.

Dimensional parameters: Dimensional parameters were significantly improved (P<0.05) in the treatments containing CSLP compared to control samples. An increase in height and shrinkage in breadth and length of CSLP incorporated meat cutlets might be due to an increase in cooking yield due to better moisture retention properties of dietary fibre of CSLP leading to swelling of cutlets. Singh et al. (2015a) also reported a significant (P<0.05) increase in height and decrease in breadth and length of chicken meat cutlets upon the incorporation of carrot powder. Similar improvements in dimensional parameters have also been reported by Gamit et al. (2020) by incorporating finger millet flour in chicken cutlets and Singh et al. (2015c) in cutlets incorporated with processed oat powder.

Colour and texture profile analysis: CSLP incorporated spent hen meat cutlets had a significant (P<0.05) effect on colour and textural profile (Table 4). The L* values for T3 were significantly (P<0.05) higher compared to control cutlets. This might be due to the formation of a lighter colour product by the addition of CSLP. Similar findings have been documented by Perna et al. (2019) in rabbit meat added with cauliflower leaf powder. Significant (P<0.05) decreasing trend was observed for a* values in all the treatments with the incorporation of CSLP. The decrease in redness (a* values) could be due to the green colour of cauliflower stems and leaves powder which imparted a green appearance to fried meat cutlets. Kumar et al. (2013) also recorded a significant (P<0.05) decrease in redness upon the incorporation of broccoli powder in emu meat nuggets. Similarly, Tyagiet al. (2020) reported a significant (P<0.05) decrease in a* values due to the presence of phytochemicals like phenolics and flavonoids in giloy stem powder incorporated cookies which imparted dark colour upon cooking. The b* values for T2 and T3 were significantly (P<0.05) higher as compared to T1 and control samples. This might be due to the presence of high carotenoid content in cauliflower stem and leaves powder which imparted a yellow appearance to meat cutlets upon frying. Significant (P<0.05) improvement in yellowness (b* values) with the incorporation of oats in chevon meat cutlets has also been reported by Singh et al. (2015b). These findings are also in agreement with the observations of Salem and Ahmed (1998), who noticed a significant increase in lightness (L* values) and yellowness (b* values) of beef patties incorporated with sweet potato and carrot at a 10% level. Chroma value (Cab*) and Hue angle (Hab**°**) are dependent on a* and b* values and remain significantly (P<0.05) higher in T2 and T3 compared to control cutlets.

The incorporation of CSLP significantly increased (P<0.05) hardness, springiness, cohesiveness, chewiness, and gumminess of meat cutlets. Hardness significantly (P<0.05) increased at all the levels of CSLP incorporation than in control. A similar trend was observed by Singh et al. (2015a) in carrot powder incorporated spent hen meat cutlets and Garcia et al. (2002) in oat and wheat incorporated low-fat fermented sausages. CSLP incorporated at three different levels had significantly (P<0.05) increased springiness of meat cutlets compared to control cutlets. This might be due to the difference in the level of interaction between cauliflower stems and leaves fibre content and meat cutlets. A similar increase in springiness was recorded in cutlets made from panga meat and chicken nuggets added with soybean hull flour (Vinayet al. 2013; Reddy et al. 2016). Cohesiveness increased significantly (p<0.05) in CSLP incorporated T3 as in most cases harder products are measured as more cohesive as compared to softer products (Vinay, 2013). Chewiness and gumminess of CSLP incorporated meat cutlets were significantly higher compared to control cutlets. A similar trend was also observed by Singh et al. (2015a) in spent hen meat cutlets added with carrot powder, Grigelmo-Miguel et al. (1999) in frankfurters added with peach fibre and Huang et al.(2005) in rice bran incorporated pork meatballs.

Sensory attributes of spent hen meat cutlets: Mean sensory scores for control samples and CSLP incorporated treatments are given in Table 4. All the sensory attributes viz. colour and appearance, flavour, juiciness, tenderness and overall acceptability showed significant (P<0.05) decreasing trends at a 6% level of CSLP incorporation. The mean flavour scores of T1 were reported comparable to control and T2 and significantly (P<0.05) higher than T3. This could be due to the masking of meat flavor by the addition of cauliflower stems and leaves powder in spent hen meat cutlets at a 6% level of incorporation. The juiciness score of T3 was recorded lowest amongst all samples. This decreased juiciness value might be due to the hardening effect of CSLP in spent hen meat cutlets. A similar finding was also reported by Gamit et al. (2020) in chicken meat cutlets incorporated with finger millet flour. Gamit et al. (2020) also reported decreased sensory attributes of chicken meat cutlets upon the incorporation of higher levels of finger millet flour. These observations are in agreement with the findings of Kumar et al.(2013) in broccoli powder incorporated emu meat nuggets and

Table 4. Instrumental colour, texture profile and sensory analysis of spent hen meat cutlets incorporated with cauliflower stems and leaves powder (Mean ±S.E)*

Parameter	Control	T1(2% CLSP)	T2 (4% CLSP)	T3 (6% CLSP)
Instrumental Colour Profile				
L*	32.49±0.98^{a}	33.56±0.63^{a}	33.41±0.41^{a}	36.33±0.65^{b}
a*	15.82±0.46^{c}	15.01±0.14^{b}	14.56±0.17^{b}	12.44±0.20^{a}
b*	18.60±0.51^{a}	18.73±0.73^{a}	21.41±0.60^{b}	23.20±0.63^{b}
Chroma (cab*)	24.46±0.33^{a}	23.74±0.61^{a}	26.16±0.41^{b}	26.33±0.57^{b}
Hue (Hab^{o})	49.61±1.42^{a}	52.03±1.04^{ab}	54.88±1.03^{b}	61.75±0.74^{c}
Texture Profile				
Hardness (N/cm2)	9.83±0.39^{a}	13.43±0.24^{b}	14.23±0.34^{b}	15.54±0.59^{c}
Springiness (cm)	8.25±0.58^{a}	9.77±0.32^{b}	10.68±0.29^{b}	10.87±0.29^{b}
Stringines(mm)	18.53±0.56	18.38±0.80	19.41±0.46	20.25±0.47
Cohesiveness (ratio)	0.61±0.02^{a}	0.63±0.02^{ab}	0.66±0.02^{ab}	0.72±0.06^{b}
Chewiness (N/cm)	42.99±1.07^{a}	63.75±1.69^{b}	77.16±4.79^{c}	99.81±3.35^{d}
Guminess (N/cm2)	5.91±0.15^{a}	8.97±0.20^{b}	9.64±0.58^{b}	12.72±0.76^{c}
Sensory Attributes				
Appearance	7.36±0.03^{c}	7.35±0.03^{c}	7.24±0.02^{b}	6.98±0.03^{a}
Flavour	7.32±0.05^{c}	7.25±0.02^{bc}	7.19±0.03^{b}	6.87±0.04^{a}
Juiciness	7.27±0.05^{c}	7.21±0.04^{bc}	7.07±0.08^{b}	6.82±0.04^{a}
Tenderness	7.27±0.09^{c}	7.14±0.04^{bc}	7.05±0.08^{b}	6.84±0.04^{a}
Overall acceptability	7.29±0.06^{c}	7.24±0.05^{bc}	7.11±0.05^{b}	6.86±0.03^{a}

(Mean±S.E)* n=9 for colour and textural analysis whereas n=36 for sensory analysis.Means with different superscripts differ significantly ($P < 0.05$) in a row.

Vinayet al.(2013) in chicken nuggets added with green banana and soybean hull flour. The overall acceptability of spent hen meat cutlets incorporated with a 2% level of cauliflower stems and leaves powder (T1) was comparable to control and T2. At 6% CSLP incorporation, panelists perceived a marked impact on all sensory attributes, especially flavour and tenderness. Based on sensory scoring, a 4% level of CSLP incorporation was selected as optimum for the preparation of high-fibre spent hen meat cutlets.

CONCLUSION

Based on various analytical parameters viz. physicochemical, proximate, dimensional, textural, colour and sensory attributes, spent hen meat cutlets of very good acceptability and nutritive value could be developed by utilizing 4% cauliflower leaves and stem powder in the formulation.

COMPETING INTERESTS

The authors do not have any competing interests among themselves or others related to this research work.

ETHICS STATEMENT

Not applicable.

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