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Proximate, Minerals and Microbial Properties of Chickpea Nuggets Supplement with Green Leaf Powder

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***Abstract*:** This study was undertaken with the objectives to prepare nuggets with improved nutritional value and better utilization of underutilized green leaf. The proximate composition of green leaf powder blended chickpea nuggets, moisture content, crude protein content and crude fat content decrease with the increase in the level of green leaf powder while as the total ash content of nuggets increased with the increased in incorporation level of green leaf powder. The highest mean crude fiber total ash and available carbohydrate content of 3.57 , 6.05, 67.51 per cent, respectively were recorded in T_7(82:18::chickpea flour**:** green leaf powder).The calcium and iron content of green leaf powder blended chickpea nuggets increased with the increasing level of green leaf powder. The highest mean calcium and iron content of 236.08 and 10.00 mg per 100g was recorded in T_7(82:18::chickpea flour**:** green leaf powder).The microbial load of green leaf powder blended chickpea nuggets was within the permissible limits of BIS (4×10^4 cfu mL^{-1}) throughout storage period of three months.

***Keywords*:** Proximate, Nuggets, Incorporation, Permissible limits, BIS, Chickpea flour**,** Green leaf powder

Today's health-conscious consumers demand for high quality, shelf-stable and ready-to-use processed food products that are convenient and promote health (Joshi et al 2019). Nugget is a convenience food that is healthy, sensory acceptable and convenient to consumed. Pulse flours and fractions have been used as ingredients in the formulation of meat products (e.g., sausages, nuggets, burgers, etc.) successfully (Boye et al 2010). The use of green leaf powder as a dietary supplement is thus increasing in parallel with the research on its multitudinous effects on human health and designer foods. Amaranthus have been domesticated as leaf vegetables, potherbs, ornamentals or as fodder (Kachiguma 2015) and is available abundantly during rainy season and are very good source of calcium ranging from 300-800 mg/100 gm. The amaranth being rich in protein, calcium and iron can be used as supplement in cereal based diets and consumption of these nutrient rich products can contribute significantly towards improving the nutritional status of the population, (Singh et al 2014). Radish (*Raphanus sativus* L) is the one of the most ancient, cool season and cold tolerant root vegetable of *Brassicaceae* family. The leaves of radish are good source of protein and found to have biological value of 76.6 with the digestibility co-efficient of 73.5% may be due to the presence of nitrogenous fraction of t twenty-two amino acids (Ankita and Prasad 2015). Chickpea (*Cicer arietinum* L.), commonly known as Bengal gram or gram, belongs to the family *Fabaceae,* is one of the most important and widely consumed leguminous crop in India. Chickpea is known to be a good source of carbohydrates, proteins, vitamins and minerals and contains high protein (20.3-24.5%) and the protein quality is considered to be better than other pulses. It is low in fat and sodium content and as such, beneficial for diabetics and hypertensive individuals. It is considered as a 'functional food' along with its role in providing protein and fiber (Alrayyes 2018). Keeping in view the consumers demand and overall health benefits of chickpea and green leaf powder (Amaranthus and radish), this study was undertaken with the objectives to prepare nuggets with improved nutritional value which requires less time for preparation and better utilization of underutilized green leaf.

MATERIAL AND METHODS

Preparation of raw materials: The healthyradish and amaranth leaves were washed, blanched (80°C for 3min), dried (5-6 hrs at 55°C, tray dryer), crushed and mixed to prepared green leaf powder in the ratio of 50:50::radish: green leaf powder. The split dehulled chickpea was cleaned, washed and soaked for 10-12 hrs. The soaked chickpea was steamed (80°C for 10 min), dried (cabinet dryer, 55-60°C) and then finally ground into flour.

Formulation of nuggets: Seven formulations of nuggets with different percentage of chickpea flour and green leaf powder have been formulated in this study. Nuggets preparation was started by blending chickpea flour and green leaf powder in different ratios (100:0, 97:3, 94:6, 91:9, 88:12, 85:15, 82:18) along with 30g corn flour (as binder) and coarse

ground spice blend (1gm coriander, 1.5gm black pepper, 1gm zeera, 1.5gm coarse red chilli powder, 5gm salt). A chickpea nugget (100:0) was chosen as reference and control sample (Fig. 1).

Analysis of proximate composition: Moisture content in the samples was determined by following the oven drying method as the loss in weight due to evaporation from sample at a temperature of 105±1°C. The crude protein content was determined by micro Kjeldahl method, using the factor 6.25 for converting nitrogen content into crude protein (Sadasivam and Manickam 2008). Crude fat (Soxhlet extraction technique) and total ashwere estimated as per methodology given in AOAC (2005). The available carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, crude fat and crude protein and ash contents from 100 according to AOAC (2005).

Mineral content: The mineral contents were determined after the ash determination. The ash residue of each formulation was digested with perchloric acid and nitric acid (1:4) solution. The samples were left to cool and contents were filtered through Whatman filter paper 42. Each sample solution was made upto a final volume of 25 ml with distilled water (AOAC, 2005). The aliquot was used separately to determine the mineral contents of calcium and iron by using an Atomic Absorption Spectrophotometer (Spectra AA 220, USA Varian).

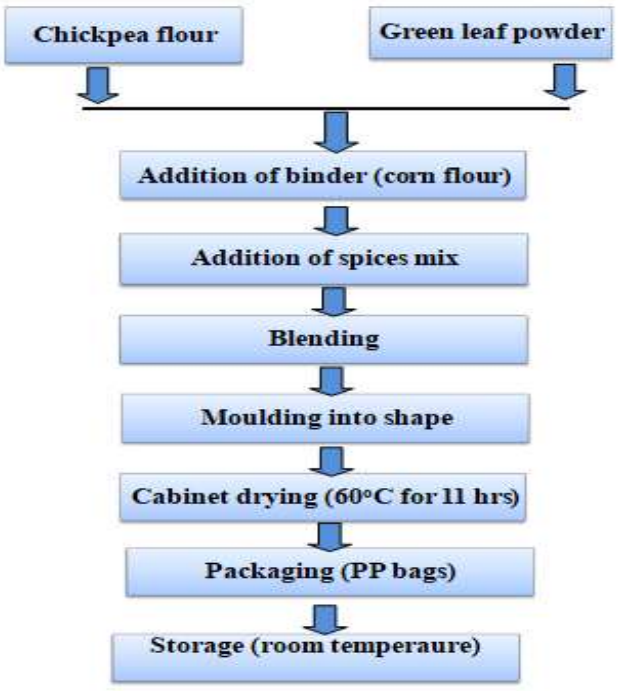

Fig. 1. Flow chart for preparation of green leaf powder blended chickpea nuggets

Microbial analysis (Total microbial count): Spread plate technique, described by Palczar and Chan (1991) was followed. 1g of sample was aseptically transferred into test tube containing 9 ml of sterile water and was mixed vigorously. After mixing, 1ml of this mixture was again transferred to a test tube containing 9 ml sterile water for further dilution. The process was continued until 4th dilution (10^{-4}). Nutrient agar was inoculated with 0.1 ml of diluted sample (10^{-4}), by spread plating technique and incubated at 37°C for 24 hours. Colonies were counted and multiplied by dilution factor.

Statistical analysis: The results obtained were statistically analyzed using completely randomized design (CRD) and CRD factorial.

RESULTS AND DISCUSSION

Proximate composition of green leaf powder blended chickpea nuggets: The maximum mean moisture content of 9.76 percent was in T_1 (Control nuggets) while as least of 7.78 percent for T_7 (Table 1). The supplementation of green leaf powder decreased the moisture content of green leaf powder blended chickpea nuggets. The decrease in moisture content might be because of low moisture content in green leaf powder in comparison to chickpea. Elhadi et al (2017) reported decreased in moisture content of chicken patties with the increase of moringa leaf powder is in line with our findings. Similar to present observation the moisture content of raw beef patties decreased as the percentage of moringa flour increased (Al-juhaimi et al 2017). Hawashin et al (2016) reported that the moisture content of raw beef patties gradually decreased as the concentration of defatted olive cake increased. The mean moisture content of green leaf powder blended chickpea nuggets increased from 7.81 to 9.72 percent during three months of storage. Khatoniar et al (2018) observed gradual increase in moisture content of dehydrated greens incorporated value added products.. Similarly, Bashir et al (2019) and Slathia et al (2016) also mentioned the increase in the moisture content of meat analog nuggets incorporated with flaxseed powder and noodles made with wheat flour supplemented with germinated mung bean flour during storage.

The maximum and minimum mean crude protein content of 21.49 and 17.90 percent were T_1 control and T_7, respectively. The supplementation of green leaf powder decreased crude protein content of green leaf powder blended chickpea nuggets and is attributed due to the fact that crude protein content of chickpea is more than the greens. Mendiratta et al (2013) reported lower protein

content in vegetable nuggets than control due to lower protein content of vegetables. Similar finding has been reported by Bhosale et al (2011) for carrot and meshed potato incorporated chicken nuggets.During storage period of three months, the crude protein content decreased from 20.10 to 18.35 percent in green leaf powder blended chickpea powder. Verma et al (2010) and Kassem and Emara (2010) also reported a reduction in protein content during storage.

The highest mean crude fat content of 2.98 per cent was in T_1 (Control nuggets) while as least of 2.21 percent in T_7 as reflected. The supplementation of green leaf powder decrease the crude fat content of green leaf powder blended chickpea nuggets. The decrease in crude fat content might be because of low crude fat content in green leaf powder in comparison to chickpea. Sharma et al (2015) reported a decreased in crude fat of nuggets with the increase in mushroom fortification. Similar to present observation, the crude fat content of *dhokla* decreased as the percentage of dehydrated *Celosia argentea* increased (Gupta and Prakash 2011). The mean crude fat content of green leaf powder blended chickpea nuggets decreased from 3.61 to 1.76 percent during three months of storage. Khursheed (2014) also reported a decreased in crude fat content of high fiber chicken meat ball blended with knol khol. Similar trend was also observed by Sanchez-Escalante et al (2001) and Fernández-López et al (2004). Ash content is the measure of total amount of minerals present within a food. The maximum and minimum mean ash content of 6.05 and 3.88 percent were in T_7 and T_1, respectively (Table 2). The supplementation of green leaf powder increased ash content of nuggets and is due to the fact that ash content of vegetables added in the product is high as compare to chickpea.The ash content of moringa muffin showed an increase which indicate higher amount of minerals in it attributed by dried moringa leaf powder incorporation (Srinivasamurthy et al 2017). Mouminah (2015) observed significance enhancement in ash content of moringa cookies. During storage period of three months, the ash content decreased from 4.88 to 4.59 percent in green leaf powder blended chickpea nuggets. The decrease in ash content might be due to increase in moisture content and mineral loss by Millard reaction during storage (Nadarajah and Mahendra 2015). Hasanuzzaman et al (2014) also reported a reduction in ash content of tomato candy during storage. The results are in accordance with Bashir (2019) who reported a decrease in total ash content during storage period of six month in meat analog nuggets.

The highest mean crude fiber content of 3.67 percent was in T_7 while as least of 2.32 percent recorded for treatment T_1 (control nuggets) (Table 3). The supplementation of green leaf powder increase the crude fiber content of green leaf powder blended chickpea nuggets. The increase in crude fiber content might be attributed to high crude fiber content in green leaf powder in comparison to chickpea. Hernandez et al (2016) reported that pastas with both amaranth flour and leaves demonstrated the highest crude fiber content. Singh et al (2009) reported increase in crude fiber content of amaranth powder supplemented biscuits. The mean crude fiber content of green leaf powder blended chickpea nuggets decreased from 3.61 to 1.76 percent during three months of storage period. Rathod (2015) also reported a decrease in crude fiber content of multigrain cookies formulated from partially defatted soy and oat flour. The least mean available carbohydrate content of 62.72 per cent was for T_1 control while as T_7 reflected highest mean available carbohydrate

Table 1. Effect of treatment and storage on moisture content (%), crude protein content (%) and crude fat (%) of green leaf powder blended chickpea nuggets

Treatment	Storage periods (Months)				Mean	Storage periods (Months)				Mean	Storage periods (Months)				Mean
	0	1	2	3		0	1	2	3		0	1	2	3	
T_1 (100:00::CP:GLP)	8.88	9.39	9.92	10.83	9.76	22.25	21.97	21.10	20.63	21.49	4.07	3.12	2.62	2.09	2.98
T_2 (97:3::CP:GLP)	8.27	8.80	9.32	10.12	9.13	21.46	21.05	20.57	19.60	20.67	3.92	2.95	2.46	1.91	2.81
T_3 (94:6::CP:GLP)	8.00	8.55	9.13	9.91	8.90	20.55	20.10	19.45	18.10	19.55	3.77	2.73	2.31	1.80	2.65
T_4 (91:9::CP:GLP)	7.82	8.36	8.94	9.74	8.72	19.87	19.50	18.81	18.01	19.05	3.61	2.66	2.24	1.73	2.56
T_5 (88:12::CP:GLP)	7.53	8.03	8.59	9.42	8.39	19.29	19.01	18.53	17.75	18.65	3.46	2.50	2.09	1.67	2.43
T_6 (85:15::CP:GLP)	7.30	7.84	8.42	9.28	8.21	18.85	18.58	17.97	17.21	18.15	3.31	2.46	2.06	1.65	2.37
T_7 (82:18::CP:GLP)	6.88	7.50	8.02	8.72	7.78	18.45	18.20	17.81	17.15	17.90	3.16	2.29	1.90	1.49	2.21
Mean	7.81	8.35	8.91	9.72		20.10	19.77	19.18	18.35		3.61	2.67	2.24	1.76	
	Effects			C.D. (p=0.05)		Effects			C.D. (p=0.05)		Effects			C.D. (p=0.05)	
	Treatment			0.05		Treatment			0.08		Treatment			0.02	
	Storage			0.02		Storage			0.10		Storage			0.01	
	Treatment × Storage			0.03		Treatment × Storage			0.05		Treatment × Storage			0.03	

CP: Chickpea flour; GLP: Green leaf powder

content of 67.51 (Table 3). The available carbohydrate increased with increasing the level of green leaf powder this might be attributed to higher available carbohydrate in green leaf powder. During storage period of three months, the available carbohydrate content increased from 63.59 to 67.57 percent in green leaf powder blended chickpea nuggets. The increase in available carbohydrate content might be due to degradation of polysaccaharide into simple sugar (Jan, 2018). Similar findings were reported by Chukwu and Abdullahi (2015) while analyzing the effects of storage period on proximate composition of cassava flour.

Minerals composition of nuggets: The highest mean calcium content of 238.06 mg per 100g was in T_7 while as least of 139.00 mg per 100g in T_1(control nuggets) (Table 3). The supplementation of green leaf powder increased the calcium content of green leaf powder blended chickpea nuggets. The increase in calcium content might be attributed to high calcium content in green leaf powder in comparison to chickpea. The maximum and minimum mean iron content of 10.00 and 5.49 mg per 100g were in T_7 and T_1 control respectively (Table 4). The supplementation of green leaf powder increased iron content of green leaf powder blended chickpea nuggets. The increase in iron content is attributed due to the fact that iron content of green leaves powder added in the product is high than the chickpea. Sengev et al (2013) reported a remarkable increase in mineral content upon increasing the level of supplementation of wheat flour with moringa leaf powder. An increased iron content of blended flour (wheat and Amaranthus) with increased incorporation level of amaranth was also reported by Emire

Table 2. Effect of treatment and storage on total ash content (%), crude fiber (%) and available carbohydrate content (%) of green leaf powder blended chickpea nuggets

Treatment	Storage periods (Months)				Mean	Storage periods (Months)				Mean	Storage periods (Months)				Mean
	0	1	2	3		0	1	2	3		0	1	2	3	
T_1 (100:00::CP:GLP)	3.53	3.49	3.42	3.33	3.44	2.45	2.38	2.25	2.18	2.32	61.27	62.10	63.25	64.26	62.72
T_2 (97:3::CP:GLP)	3.98	3.93	3.85	3.76	3.88	2.75	2.50	2.37	2.10	2.43	62.37	63.54	64.60	66.22	64.18
T_3 (94:6::CP:GLP)	4.43	4.39	4.20	4.11	4.28	3.06	2.85	2.45	2.17	2.63	63.25	64.48	65.69	66.73	65.04
T_4 (91:9::CP:GLP)	4.88	4.74	4.65	4.56	4.71	3.36	2.97	2.58	2.34	2.81	63.82	65.16	66.53	67.83	65.84
T_5 (88:12::CP:GLP)	5.33	5.18	5.12	5.03	5.17	3.67	3.29	2.76	2.46	3.05	64.39	65.81	67.22	68.64	66.52
T_6 (85:15::CP:GLP)	5.78	5.64	5.57	5.47	5.62	3.97	3.56	2.99	2.65	3.29	64.76	66.01	67.98	69.44	67.05
T_7 (82:18::CP:GLP)	6.23	6.07	5.99	5.90	6.05	4.28	3.82	3.20	2.96	3.57	65.28	66.52	68.40	69.85	67.51
Mean	4.88	4.78	4.69	4.59		3.36	3.05	2.66	2.41		63.59	64.80	66.24	67.57	
	Effects	C.D. (p=0.05)				Effects	C.D. (p=0.05)				Effects	C.D. (p=0.05)			
	Treatment	0.08				Treatment	0.03				Treatment	0.03			
	Storage	0.02				Storage	0.02				Storage	0.02			
	Treatment × Storage	0.02				Treatment × Storage	0.05				Treatment × Storage	0.05			

CP: Chickpea flour; GLP: Green leaf powder

Table 3. Effect of treatment and storage on calcium (mg/100g), iron content (mg/100g) and microbial count (□10^4 c.f.u/g) of green leaf powder blended chickpea nuggets

Treatment	Storage periods (Months)				Mean	Storage periods (Months)				Mean	Storage periods (Months)				Mean
	0	1	2	3		0	1	2	3		0	1	2	3	
T_1 (100:00::CP:GLP)	139.10	139.02	138.86	138.51	139.00	5.82	5.71	5.40	5.02	5.49	ND	ND	0.240	0.831	0.536
T_2 (97:3::CP:GLP)	147.56	147.31	147.08	146.85	147.23	6.91	6.82	6.53	6.13	6.60	ND	ND	0.231	0.786	0.509
T_3 (94:6::CP:GLP)	164.48	164.30	163.93	163.51	164.23	7.42	7.29	6.92	6.64	7.07	ND	ND	0.218	0.719	0.469
T_4 (91:9::CP:GLP)	179.86	179.54	179.06	178.37	179.64	7.79	7.08	6.76	6.50	7.03	ND	ND	0.205	0.653	0.429
T_5 (88:12::CP:GLP)	193.70	193.32	192.70	192.31	193.44	8.35	8.20	7.87	7.32	7.94	ND	ND	0.190	0.590	0.390
T_6 (85:15::CP:GLP)	217.34	216.93	216.27	215.79	217.33	9.21	9.05	8.75	8.18	8.80	ND	ND	0.175	0.484	0.330
T_7 (82:18::CP:GLP)	238.30	237.88	237.36	236.80	238.06	10.45	10.34	9.89	9.33	10.00	ND	ND	0.150	0.452	0.301
Mean	182.93	182.79	182.62	182.48		7.99	7.78	7.45	7.02		ND	ND	0.201	0.645	
	Effects	C.D. (p=0.05)				Effects	C.D. (p=0.05)				Effects	C.D. (p=0.05)			
	Treatment	1.03				Treatment	0.10				Treatment	0.04			
	Storage	NS				Storage	0.01				Storage	0.02			
	Treatment × Storage	0.05				Treatment × Storage	0.03				Treatment × Storage	0.05			

CP: Chickpea flour; GLP: Green leaf powder

and Arega (2012). Veena et al (2019) also reported increased iron in beetle leaf incorporated pasta. The mean calcium and iron content of green leaf powder blended chickpea nuggets decreased from 182.93 to 182.48 and 7.99 to 7.02 mg per 100g, respectively during three months of storage periods (Fig. 2). The decrease in minerals content of green leaf powder blended chickpea nuggets might be due to interaction of these minerals with protein and carbohydrate (Millard reaction products) making them unavailable(Akhtar et al 2010). Sharma et al (2017) observed decrease in mineral content of flaxseed blended cracker throughout storage.

Microbial evaluation of nuggets (Total microbial count): The microbial load of green leaf powder nuggets was significantly affected by treatment (Table 3). The highest mean total microbial count of 0.536×10^4 (c.f.u/g) was in T_1 (100:00::CP:GLP) whereas the lowest of 0.301×10^4 (c.f.u/g) in T_7 (82:18::CP:GLP).The supplementation of green leaf powder decreased the microbial load of green leaf powder blended chickpea nuggets because low pH value inhibit the growth of microorganism and reduce the content of biogenic amines. Ahn et al (2019) and Mendiratta et al (2013) also reported that the addition of dried radish leaves and roots reduce the pH, prevents microbial growth and affects lipid oxidation. Shinde (2006) observed antimicrobial effect of radish in pork patties are in line with our findings. With the advancement of storage period the total microbial count of green leaf powder blended chickpea nuggets increased significantly from 0 to 0.645×10^4 (c.f.u/g). The increase in microbial count during storage may be due to increase in moisture content of nuggets that provides favourable environment for microbial growth (Chakroborty and Chakroborty 2017). Nisha (2008) also reported an increase in microbial load during storage of green gram-based meat analog. The microbial load of green leaf powder blended chickpea nuggets was within the permissible limits of BIS (4×10^4 cfu mL^{-1}) throughout storage period of three months.

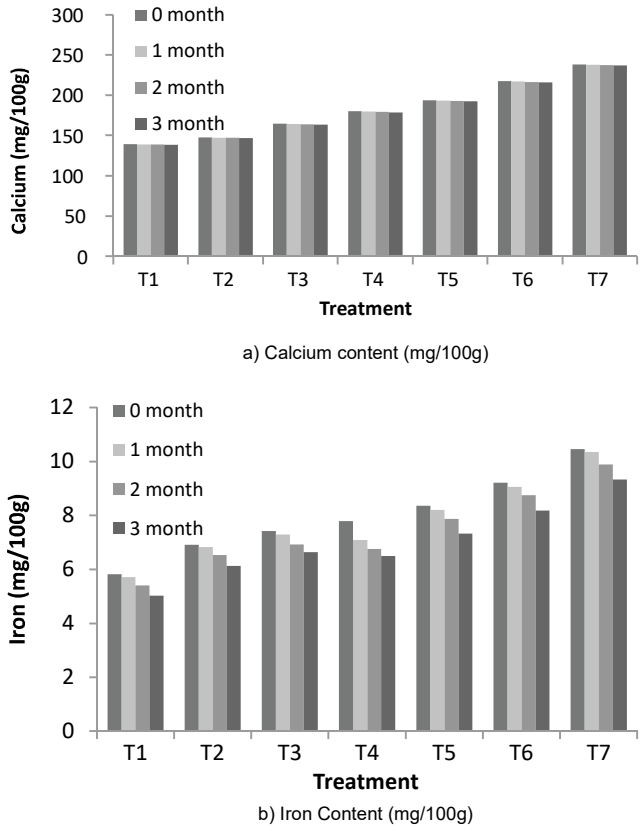

Fig. 2. Effect of treatment and storage on (a) calcium content (mg/100g) and b) iron content (mg/100g) of green leaf powder blended chickpea nuggets

CONCLUSION

The increase in level of green leaf powder in the nuggets formulation resulted in nuggets with a higher ash, fibre, calcium and iron content which was an objective of this study. Thus, nutritionally rich nuggets can be prepared from blending underutilized green leaf powder. The green leaf powder blended nuggets formulated in this study being highly nutritious can be recommended for malnourished children.

REFERENCES

Ahn SJ, Kim HJ, Lee N and Lee CH 2019. Characterization of pork patties containing dry radish (*Raphanus sativus*) leaf and roots. *Asian-Australasian journal of Animal Sciences* **32**(3): 413-420.

Akhtar S, Anjum FM, Salim-Ur- Rehman and Sheikh MA 2010. Effect of storage and baking on mineral contents of fortified whole wheat flour. *Journal of Food Processing and Preservation* **34**(2): 335-349.

Al-Juhaimi F, Adiamo OQ, Alsawmahi ON, Gahfoor K, Islam Sarker MZ, Mohamed Ahmed IA and Babiker EE 2017. Effect of pistachio seed hull extracts on quality attributes of chicken burger. *CyTA-Journal of Food* **15**(1): 9-14.

Alrayyes WH 2018. Nutritional and health benefits enhancement of wheat-based food products using chickpea and distiller dried grain. *Electronic Thesis and Dissertations* 2474.

Ankita PK and Prasad K 2015. Characterization of dehydrated functional fractional radish leaf powder. *Der Pharmacia. Lettre* **7**(1): 269-279.

AOAC 2005. *Official Methods of Analysis.* 17thedn, Association of Official Analytical Chemists, Washington D.C.

Bashir N 2019. *Formulation and evaluation of functional meat analogue based on mushroom, flaxseed and amaranth*. Ph.D thesis. Sher-e-Kashmir University of Agricultural Science and Technology of Jammu, Jammu and Kashmir, India.

Bashir N, Sood M, Bandral JD and Ashraf S 2019. Impact of storage on quality parameters of meat analog nuggets formulated from oyster mushroom, flaxseed and amaranth. *Applied Biological Research* **21**(3): 265-273.

Bhosale SS, Biswas AK, Sahoo J, Chatli MK, Sharma DK and Sikka SS 2011. Quality evaluation of functional chicken nuggets incorporated with ground carrot and mashed sweet potato. *Food Science and Technology International* **17**(3): 233-239.

Boye J, Zare F and Pletch A 2010. Pulse proteins: Processing, characterization, functional properties and applications in food and feed. *Food Research International* **43**(2): 414-431.

Chakroborty T and Chakroborty SC 2017. Effect of storage temperature on the quality and microbial content of salt-smoke-dried shoal (*Ophiocephalus striatus*). *Journal of Fisheries and Livestock Production* **5**(1): 1-4.

Chukwu O and Abdullahi H 2015. Effects of moisture content and storage period on proximate composition, microbial counts and total carotenoids of cassava flour. *International Journal of Innovative Science, Engineering and Technology* **2**(11): 753-763.

Elhadi DA, Elgasim EA and Mohamed Ahmed IA 2017. Microbial and oxidation characteristics of refrigerated chicken patty incorporated with moringa (*Moringa oleifera*) leaf powder. *CyTA-Journal of Food* **15**(2): 234-240.

Emire SA and Arega M 2012. Value added product development and quality characterization of amaranth (Amaranthus caudatus L.) grown in East Africa. *African Journal of Food Science and Technology* **3**(6): 129-141.

Fernandez-Lopez J, Fernandez-Gines JM, Aleson-Carbonell L, Sendra E, Sayas-Barbera E and Perez-Alvarez JA 2004. Application of functional citrus by-products to meat products. *Trends in Food Science and Technology* **15**(3-4): 176-185

Gomez KA and Gomez AA 1984. *Statistical Procedures for Agriculture Research*, 2nd edition. Pp 1-690. Whiley-Interscience Publication, John Wiley and Sons, New York.

Gupta S and Prakash J 2011. Nutritional and sensory quality of micronutrient-rich traditional products incorporated with green leafy vegetables. *International Food Research Journal* **18**(2): 667-676.

Hasanuzzaman M, Kamruzzaman M, Islam MM, Khanom SAA, Rahman MM, Lisa LA and Pual DK 2014. A study on tomato candy prepared by dehydration technique using different sugar solutions. *Food and Nutrition Sciences* **5**(13): 1261-1271.

Hawashin MD, Al-Juhaimi F, Ahmed IAM, Ghafoor K and Babiker EE 2016. Physicochemical, microbiological and sensory evaluation of beef patties incorporated with destoned olive cake powder. *Meat science* **122**: 32-39.

Hernández A, Beta T, Loarca-Pina G, Castano-Tostado E, Nieto-Barrera JO and Mendoza S 2016. Improved functional properties of pasta: enrichment with amaranth seed flour and dried amaranth leaves. *Journal of Cereal Science* **72**: 84-90.

Jan A 2018. *Effect of gamma-irradiation on quality characteristic of brown rice based weaning food.*Ph.D thesis. Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India.

Joshi N, Bains K and Kaur B 2019. Optimized drying time and temperature for preparation of antioxidant rich vegetable powder from unconventional leafy greens. *Chemical Science Review and Letter,* **8**(29): 70-78.

Kachhawa K and Chawla P 2017. Improvement in nutritional quality of commonly consumed products with supplementation of drumstick leaves (*Moringa oleifera* L.). *International Journal of Home Science* **3**(2): 478-485.

Kachiguma NA, Mwase W, Maliro M and Damaliphetsa A 2015. Chemical and mineral composition of amaranth (*Amaranthus* L.) species collected from central Malawi. *Journal of Food Research* **4**(4): 92-102.

Kadam ML, Salve RV, Mehrajfatema ZM and More SG 2012. Development and evaluation of composite flour for Missi roti/chapatti. *Journal of Food Processing and Technology* **3**(1): 1-7.

Kassem MA and Emara MMT 2010. Quality and acceptability of value added beef burger. *World Journal of Dairy and Food Sciences* **5**(1): 14-20.

Khatoniar S and Barooah MS 2018. Quality evaluation of dehydrated green leafy vegetables during storage. *Pharmaceutical Innovation Journal* **7**: 234-238.

Khursheed I 2014. *Development and evaluation of high fiber meat balls from chicken.* M.Sc. thesis. Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India.

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Mendiratta SK, Shinde AT and Mane BG 2013. Effect of added vegetable (carrot, radish and capsicum) as functional ingredients in mutton nuggets. *Journal of Meat Science and Technology* **1**(2): 71-76.

Mouminah HH 2015. Effect of dried *Moringa oleifera* leaves on the nutritional and organoleptic characteristics of cookies. *Alexandria Science Exchange Journal* **36**(4): 297-302.

Nadarajah S and Mahendran T 2015. Influence of storage conditions on the quality characteristics of wheat-defatted coconut flour biscuits packed in metalized polypropylene. *International Journal of Engineering Research* **4**(07): 949-951.

Nisha 2008. *Standardization of green gram based meat analogue*. M.Sc thesis. Kerala Agricultural University, Kerala, India.

Palczar MJ and Chan ECS 1991. *Laboratory Exercise in Microbiology*. Black Dot Inc., New York.

Pant R, Chawla P, Sadana B and Kushwaha S 2012. Development and Nutritional evaluation of cereal pulse based snacks using drumstick leaves. *Journal of Research* **49**: 99-103.

Rathod RN 2015. *Standardization process for preparation of multigram cookies*. M.Sc. thesis. Mahatma Phule Krishi Vidyapeeth, Ahmednagar, Gujarat, India.

Sanchez-Escalante A, Torrescano G, Beltron JA and Ronales P 2001. The effect of ascorbic acid, taurine, carnoise and rosemary powder on colour and lipid stability of beef patties packaged in modified atmosphere. *Meat Science* **58**: 421-429.

Sadasivam S and Manickam A 2008. Antinutritional factors In: *Biochemical Methods*. Pp 215-216. New International (P) Ltd, New Delhi, India.

Sengev AI, Abu JO and Gernah DI 2013. Effect of Moringa oleifera leaf powder supplementation on some quality characteristics of wheat bread. *Food and Nutrition Sciences* **4**(3): 270-275.

Sharma A, Vaidya D, Abrol GS, Rana N and Chauhan N 2015. Functional and textural properties of Indian nuggets assorted with mushroom for lysine enrichment. *Journal of Food Science and Technology* **52**(6): 3837-3842.

Sharma R, Sood M and Bandral JD 2017. Chemical and mineral composition of defatted flaxseed flour incorporated crackers. *International Journal of Food and Fermentation Technology* **7**(1): 33-40.

Shinde AT 2006. *Studies on pork patties extended with Onion, carrot, radish and sweet potato*. Ph.D. thesis. Indian Veterinary Research Institute, Izatnagar, Uttar pardesh, India.

Singh S, Punia D and Khetarpaul N 2009. Nutrient composition of products prepared by incorporating amaranth (*Amaranthus tricolour*) leaf powder. *Nutrition and Food Science* **39**(3): 218-226.

Singh P, Singh S, Singh BR, Singh J and Singh SK 2014. The drying characteristics of amaranth leaves under greenhouse type solar dryer and open sun. *Greener Journal of Agricultural Science* **4**: 281-287.

Slathia N, Bandral JD and Sood M 2016. Quality evaluation of noodles supplemented with germinated mungbean flour. *International Journal of Food and Fermentation Technology* **6**(2): 451-456.

Srinivasamurthy S, Yadav U, Sahay S and Singh A 2017. Development of muffin by incorporation of dried *Moringa oleifera* (Drumstick) leaf powder with enhanced micronutrient content. *International Journal of Food Science and Nutrition* **2**(4): 173-178.

Veena BM, Shivaleela HB and Usha R 2019. Enhancement of nutritional quality of pasta by incorporating underutilized greens. *Journal of Pharmacognosy and Phytochemistry* **8**(4): 3118-3121.

Verma AK, Sharma BD and Banerjee R 2010. Effect of sodium chloride replacement and apple pulp inclusion on the physic-chemical, textural and sensory properties of low fat chicken nuggets. *Food Science and Technology* **43**(4): 715-719.