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Development and evaluation of cereal-legume based ladoo supplemented with ashwagandha (*Withania somnifera*)

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Abstract
In the present study value added *ladoos* were prepared from variations of cereal-legume blend and *ashwagandha*. Three variations of control *ladoo* with different level of cereal and legume (without *ashwagandha* supplementation) were prepared. In each variation, *ashwagandha* root powder at a level of 3%, 4% and 5% was added to formulate the test product. The highest mean score of overall acceptability was recorded from *ladoo* made of wheat flour, soy flour and barley flour in the ratio of 40:30:30. Since no significant difference was found in the acceptability of product containing 3%, 4% and 5% *ashwagandha* in the selected variation, therefore the product with minimum (3%) and maximum level (5%) of *ashwagandha* was selected for further nutritional and shelf life evaluation. The shelf life of the *ladoos* was found to be 30 days. The crude fat, crude fiber, total dietary fiber and mineral content improved with increase in level of *ashwagandha.* The investigation suggests that *ashwagandha* root powder upto a level of 5% can be added in sweets products for value addition to increase the fiber, fat and mainly the mineral content of the product as well as imparting curative effects to the products.

Keywords: *Ashwagandha*, value added *ladoo*, mineral, functional food, nutritional value

Introduction
Increased consumer awareness in improving overall health and reducing risk for specific diseases has fuelled the demand for foods that offer health benefits beyond their traditional nutritional significance. This has led to the growing realization of the potential of functional foods. The term 'functional foods' was first introduced in Japan. The processed foods containing nutritious ingredients that support healthy body functions are known as functional foods [12, 14]. *Ladoo* is a traditional sweet savored by people of all age groups and is energy dense food. *Ladoos* are made with variety of local ingredients and are easy to consume. The basic ingredient of *ladoo* is either wheat flour or bengal gram flour. It is commonly known that the main nutritional drawback of cereals is lack of essential amino acid lysine which can be easily compensated by supplementing cereals with legume like soybean. Soybean has great potential as an exceptionally nutritive and very rich protein food. It contains about 38 to 40 per cent protein of superior quality and 18 to 20 per cent oil [18]. Barley is a major cereal grain with many health benefits. These therapeutic potentials are attributed to the presence of many bioactive components among which beta-glucan is the most important. Barley *β*-glucan helps to alleviate dyslipidemia [10] and reduce CVD [5]. Regular consumption of barley is associated with reduced risk of various diseases, such as colonic cancer [11] and high blood pressure [6].
Nutritional and medicinal qualities of *ladoo* can be enhanced by supplementing with ingredients such as medicinal plant extract or powder [17]. Supplementation with medicinal herbs not only gives medicinal properties but can also increase nutritional value of the product imparting functional health promoting properties to the food products
Ashwgandha (*Withania somnifera*), an important herb in *Ayurveda*, has long been considered as an excellent rejuvenator, a general health tonic and a cure for a number of health complaints. It is a diuretic, analgesic [19] anti-inflammatory, [1]. Antistress [9] antioxidant [8] anticonvulsive [13] and an excellent adaptogen. It stimulates the immune system, combats inflammation, increases memory, and helps maintain general health and wellness. *Ashwagandha* exhibits a variety of therapeutic effects with little or no associated toxicity [3, 15]. But the bitter taste of this herb limits its use in raw form. Keeping in view the health benefits of *ashwagandha* as a valuable herb and the beneficial effects of use of cereal-legume blend, the present study was designed to develop a value added functional sweet product, *ladoo* from

variations in barley, low fat soy and wheat and to evaluate its sensory characteristics. The products selected by sensory analysis were further analyzed for nutritional quality and shelf life quality.

Material and methods

Raw material collection: *Ashwagandha* roots were obtained from Medicinal and Aromatic Plant Research and Development Centre, of G.B Pant University. The roots were washed, dried and then pulverized in an electric grinder. Low fat roasted soy flour was obtained from S.P solvents, Rudrapur. The low fat soy flour is made from roasted soybeans, which are mechanically oil-expelled and then grinded to fine powder which has better shelf life and characteristic good taste than normal soy flour due to decrease in amount of fat. Barley grains were purchased from the local market of Rudrapur. All other ingredients for preparation of food products were purchased from the local market of Pantnagar. Wheat and barley grains were milled to a fine powder and stored in air tight plastic container till further use.

Product Development: The *ladoos* made out of flour of wheat, low fat soy flour and barley were standardized in the lab of Department of Foods & Nutrition G.B.P.U.A.T, Pantnagar. The control products were prepared with the flour mixture in various combinations of Wheat flour, barley flour and low fat roasted soy flour. In test product *ashwagandha* root powder was added at the level of 3, 4, and 5% in the different control blends as follows:

Control **Test product**
Type I: 50:25:25 (WF: BF: LFSF) - T IA: Type I flour with ARP @ 3%, T I B: Type I flour with ARP @4%,
TI C- T IC: Type I flour with ARP @ 5%
Control **Test product**
Type II: 40:30:30 (WF: BF: LFSF) - T II A: Type II flour with ARP@ 3%, T II B: Type II flour with ARP@4%,
T II C - Type II flour with ARP@ 5%
Control **Test product**
Type III: 30:45:25(WF: BF: LFSF) - Type III A: - TIII flour with ARP@3%,Type III B: TIII flour with ARP@4%,
TIII C-TIII flour with ARP@ 5%
(WF= Wheat Flour; BF= Barley Flour; LFSF= Low fat soy flour, ARP = *Ashwagandha* root powder)
A, B, C denoted the different levels of *ashwagandha* root powder supplementation (ARP i.e. 3, 4 and 5 g)
To prepare the product, 80 g jaggery was dissolved in water and cooked to one thread consistency. The flours were roasted in 10 g of ghee for 5 min. Then 100 g of roasted flour from each blend were added to the jaggery syrup. The *ladoos* were shaped in round shape by hand and packed in polythene bags for further analysis.

Sensory evaluation
The *ladoos* were evaluated for sensory quality by a semi-trained panel of 10 members. A 9 point hedonic scale [7] was used for this purpose. The judges were requested to taste the *ladoos* and award a score with reference to a number of attributes viz. appearance, texture, colour, flavour and overall acceptability to find out the best cereal-legume variation and suitable level of *ashwagandha* in the final product. This procedure was repeated three times. The similar scores obtained in all the replications were considered acceptable.

Nutritional Composition Analysis
The nutritional analysis was carried out by AOAC 1996 method [2]. Protein content was determined by Kjeldahl method and crude fat by Soxhlete method. Mineral content was analyzed by double beam atomic absorption spectrophotometer [16].

Statistical Analysis
All the determinations were carried out in triplicates. The results are expressed as means ± SD. The original sensory panel data and other results were statistically analyzed using analysis of variance (ANOVA) at a significance of probability 5%.

Results and discussions

The data pertaining to effects of incorporation of various levels of supplementation of ashwagandha on sensory attributes of cereal-legume based *ladoo* variants has been shown in Table 1. The *ladoos* were evaluated for sensory attributes *viz.*, colour and appearance, taste, texture, taste and overall acceptability. The mean scores of organoleptic evaluation of type II & III *ladoos* were 'liked moderately' for all parameters and that of type I was liked slightly. A significant difference was obtained in the mean sensory scores of all the three types of *ladoo* which showed that the sensory scores were affected more by the type of flour blends rather than the level of *ashwagandha.*
The highest mean sensory scores were obtained by Type II *laddo* containing WF: BF: LFSF in the ratio of 40:30:30 which revealed that the *ladoos* with maximum amount of incorporation of low fat soy flour had highest sensory scores.
In T I and III a significant difference was found in the taste between control and test *ladoos* with control scoring more in all the sensory parameters whereas in T II a significant difference was found in the colour where test samples score more than the control. This was due to the reason that control sample TII consisted of higher percentage of low fat soy roasted flour which imparted a brown colour to the *ladoos* that affected the colour scores adversely. In test products TII A TII C the colour became lighter in due to the replacement of soy flour with *ashwagandha* root powder which improved the colour scores.

Table 1: Mean Scores of Sensory Evaluation of *Ladoos*

Treatments	Appearance	Colour	Texture	Taste	Flavour	Overall acceptability
TI (Control)	$6.71^{a} \pm 0.05$	$6.55^{a} \pm 0.03$	$6.60^{a} \pm 0.07$	$6.65^{a} \pm 0.07$	$6.50^{a} \pm 0.06$	$6.60^{a} \pm 0.07$
TIA	$6.50^{a} \pm 0.11$	$6.60^{a} \pm 0.07$	$6.48^{b} \pm 0.05$	$6.55^{b} \pm 0.05$	$6.27^{b} \pm 0.05$	$6.55^{a} \pm 0.07$
TIB	$6.55^{a} \pm 0.05$	$6.65^{a} \pm 0.14$	$6.43^{bc} \pm 0.06$	$6.50^{b} \pm 0.06$	$6.25^{b} \pm 0.03$	$6.50^{b} \pm 0.07$
T I C	$6.60^{a} \pm 0.11$	$6.68^{a} \pm 0.04$	$6.42^{bc} \pm 0.03$	$6.50^{b} \pm 0.13$	$6.20^{c} \pm 0.06$	$6.50^{b} \pm 0.04$
CD ($p<0.05$)	0.25	0.23	0.04	0.08	0.04	0.06
T II (Control)	$7.30^{a} \pm 0.06$	$7.20^{b} \pm 0.10$	$7.30^{a} \pm 0.03$	$7.30^{a} \pm 0.11$	$7.25^{a} \pm 0.11$	$7.30^{a} \pm 0.87$
T II A	$7.28^{a} \pm 0.14$	$7.20^{b} \pm 0.13$	$7.28^{a} \pm 0.05$	$7.20^{a} \pm 0.10$	$7.20^{a} \pm 0.11$	$7.25^{a} \pm 0.10$

T II B	7.30[a]± 0.66	7.25[b]± 0.67	7.25[a]± 0.03	7.25[a]± 0.16	7.20[a]± 0.11	7.30[a]± 0.03
T II C	7.30[a]± 0.14	7.35[a]± 0.75	7.26[a]± 0.07	7.30[a]± 0.67	7.18[a]± 0.67	7.30[a]± 0.14
CD (p<0.05)	0.10	0.09	0.10	0.10	0.10	0.09
T III (Control)	7.05[a]± 0.67	6.95[b] ± 0.67	7.05[a]± 0.67	6.95[a]± 0.67	6.90[a]± 0.67	7.00[a]± 0.67
T IIIA	6.80[b] ± 0.05	7.00[a] ± 0.08	6.90[b] ± 0.10	6.90[b] ± 0.05	6.80[b] ± 0.08	6.95[a] ± 0.05
T III B	7.05[a] ± 0.10	7.00[a] ± 0.06	7.00[a] ± 0.07	6.90[b] ± 0.06	6.80[b] ± 0.10	7.00[a] ± 0.10
T III C	7.00[a] ± 0.06	7.05[a] ± 0.10	7.05[a] ± 0.08	6.80[c] ± 0.06	6.77[b] ± 0.04	7.00[a] ± 0.05
CD (p<0.05)	0.07	0.08	0.08	0.05	0.07	0.07

All values are Mean ± SD. Values in a row with different superscript letters are significantly different, $P < 0.05$.

In TII no significant difference was obtained in overall acceptability, taste and texture of control and test *ladoos* and TII *ladoo* had highest mean scores. Therefore, T II group was selected for further evaluation.

Among type II group it was observed that the highest mean score of sensory acceptability was that of control followed by II A, B and T II *C ashwagandha.* There was no significant difference found in the mean sensory scores of overall acceptability and other sensory parameters of T II A, T II B and TIIC containing 3%, 4% and 5% of *ashwagandha*. Therefore, TII A and TIIC with minimum (3%) and maximum (5%) of *ashwagandha* supplementation were selected for further nutritional and shelf life evaluation to find out the effect of *ashwagandha* on the nutritional composition of the *laddos.*

Table 2: Proximate Composition of Selected Value added *Ladoos* (g/100 g)

Products (*Ladoo*)	**Energy (Kcal/100g)**	**Crude Protein**	**Crude Fat**	**Total ash**	**Crude Fibre**	**Carbohydrate**
T II (Control)	333.03[a] ± 8.50	14.09[a] ± 0.90	2.27[a] ± 0.21	3.10[a] ± 0.57	3.53[a] ± 0.14	64.25[a] ± 0.50
T II A	331.90[a] ± 3.08	13.95[a] ± 0.12	2.30[a] ± 0.15	3.35[b] ± 0.14	3.60[a] ± 0.49	62.85[b] ± 0.82
T II C	330.10[a] ± 0.41	13.89[a] ± 0.94	2.34[a] ± 0.00	3.60[b] ± 0.02	3.73[a] ± 0.11	63.67[a] ± 0.47
CD(p<0.05)	3.68	0.21	0.31	0.30	0.99	0.95

All values are Mean ± SD. Values in a row with different superscript letters are significantly different, $P < 0.05$.
Type II: 40:30:30 (WF: BF: LFSF) TII A: Type II flour with ARP@ 3%, T II C - Type II flour with ARP@ 5%

Table 2. depicts the data showing the results of the proximate composition of TII A and T II C *ladoos* as compared to the control. The energy value and carbohydrate content of control *ladoo* T II was more than TII A and T IIC which was due to presence of higher level of cereal flours in the control. Similarly, the protein content of control *ladoo* (14.09g) was more than TII A (13.95g) and T IIC (13.89g) which was due to presence of high protein soy flour. Whereas the crude fat, total ash and crude fiber content was found to be more in T II A and T II C which increased with increase in level of *ashwagandha* supplementation. The crude fat in TII *ladoo* was 3.35±0.14g which increased to in TII A 3.60±0.02 g (1.98%) and to 3.73±0.11 g (5.6%) in TII C *ladoo* as compared to control, showing that the presence of *ashwagandha* contributed to increase in these proximate components in the *laddos*.

Table 3: Dietary Fiber Content of Selected Value Added *Ladoos* (%)

Products (*Ladoo*)	**Dietary Fiber**	**Insoluble Fiber**	**Soluble Fiber**
T II (Control)	19.67[a] ± 4.50	15.61[a] ± 0.90	4.60[a]± 0.90
T II A	20.56[b] ± 2.08	16.26[b] ± 0.12	4.30[a]± 0.90
T II C	21.50[c]± 1.41	17.50[c] ± 0.94	4.00[a]± 0.90
CD(p<0.05)	1.60	0.21	0.30

All values are Mean ± SD. Values in a row with different superscript letters are significantly different, $P < 0.05$.
Type II: 40:30:30 (WF: BF: LFSF), TII A: Type II flour with ARP@ 3%, T II C - Type II flour with ARP@ 5%

The results of the dietary fiber content of the *ladoos* is presented in Table 3.The results revealed that the total dietary fiber content of T II C *ladoo* was maximum with a level of 21.50± 1.4. But the soluble fiber content of control was found to be comparatively higher (4.60± 0.90) than that of test *ladoos* (4.30±0.90 and 4.00± 0.90 in TII A and TIIC respectively) although no significant differences were found in control and test *ladoos*. A significant difference was found (p<0.05) in the dietary fiber content of control and test *ladoos* with the total dietary fiber content increasing with increase in the level of *ashwagandha*. The results indicated that the developed *ladoos* had good amount of fiber. Intake of dietary fiber prevents cardiovascular disease and diabetes, act as effective laxatives and help in lowering body weight [5, 6].

Table 4: Mineral Composition of the Selected Value added *Ladoos* (mg/100g)

Products (*Ladoo*)	**Iron**	**Copper**	**Magnesium**	**Zinc**	**Sodium**	**Manganese**
T II	4.55[a] ± 0.04	0.90[a] ± 0.07	97.40[a] ± 0.15	1.05[a] ± 0.05	6.00[a] ± 0.10	0.99[a] ± 0.20
T II A	5.39[b] ± 0.03	0.94[a] ± 0.04	99.30[b] ± 0.45	1.43[b] ± 0.03	15.60[b] ± 0.07	1.02[b] ± 0.27
T II C	5.54[c] ± 0.01	1.01[b] ± 0.05	100.49[c] ± 0.01	1.50[b] ± 0.02	16.20[c] ± 0.05	1.06[c] ± 0.17
CD(p<0.05)	0.08	0.11	0.55	0.07	0.15	0.02

All values are Mean ± SD. Values in a row with different superscript letters are significantly different, $P < 0.05$.
Type II: 40:30:30 (WF: BF: LFSF) TII A: Type II flour with ARP@ 3%, T II C - Type II flour with ARP@ 5%

The mineral content of the products is presented in Table 4. Results indicate that the mineral content (mg/100g) of TII A and TII C *ladoos* was higher as compared to the control. A significant difference was found in the mineral content of

control and test *ladoos* ($p<0.05$), except for copper. The value of iron content (mg/100g) of TII A was 4.55 which increased to 5.39±0.03 (18.4%) in TII and to 5.54±0.01 (21.7%) increase. The sodium content of test *ladoos* was highest among all minerals, which could be due to presence of high sodium in the *ashwagandha* root sample. The zinc content of control *ladoo* was 1.05±0.05mg which increased to 1.43± 0.03 mg in TIIA (36.1%) and 1.50±0.02 mg to TIIC (42%). The value for manganese content (mg/100g) of control *ladoo* was 0.99± 0.20 which increased to 1.02±0.27 (3.03%) in TII A and 1.06±0.47 in TII C (7.07%) respectively. Similar trend was observed in case of other minerals where percentage increase in levels of minerals was observed, with increase in level of incorporation of *ashwagandha*, with maximum percentage increase in TII C with 5% *ashwagandha* followed by T IIA containing 3% *ashwagandha* which clearly indicated that incorporation of *ashwagandha* added to mineral content of the *ladoos*. Similar observations were also reported in medicinal herb, *shatavri* incorporated *ladoos* where a significant enhancement of mineral especially iron content of the *ladoos* was found when compared with control sample demonstrating that medicinal herbs can be effectively used in sweet preparation after suitable processing [4].

Table 5: Changes in Sensory Scores of selected *Ladoos* during storage period

Treatments (*ladoos)*	Days	Appearance	Colour	Texture	Taste	Flavour	Overall acceptability
T II(Control)	0	7.30^{a}± 0.06	7.20^{a}± 0.08	7.25^{a}± 0.03	7.30^{a}± 0.11	7.25^{a}± 0.11	7.30^{a}± 0.07
	15	7.00^{a}± 0.05	7.20^{a}± 0.10	7.20^{b}± 0.05	7.00^{a}± 0.10	7.20^{a}± 0.10	7.25^{a}± 0.10
	30	6.95^{a}± 0.10	7.00^{a}± 0.06	7.10^{b}± 0.14	6.95^{c}± 0.06	7.20^{a}± 0.17	7.00^{c}± 0.04
CD ($p<0.05$)		0.57	0.20	0.15	0.31	0.20	0.50
T II A	0	7.28^{a}± 0.04	7.20^{a}± 0.03	7.28^{a}± 0.05	7.20^{a}± 0.10	7.20^{a} ± 0.10	7.25^{a}± 0.05
	15	7.20^{a}± 0.10	7.10^{a}± 0.04	7.10^{b}± 0.04	7.00^{a}± 0.07	7.00^{b}± 0.16	7.10^{b}± 0.04
	30	7.10^{a}± 0.03	7.00^{a}± 0.04	7.00^{c}± 0.07	7.00^{a}± 0.04	6.90^{b}± 0.05	7.00^{a}± 0.10
C D($p<0.05$)		0.28	0.59	0.04	0.21	0.15	0.12
TII C	0	7.30^{a}± 0.14	7.35^{a}± 0.15	7.26^{a}± 0.07	7.30^{a}± 0.17	7.18^{a}± 0.07	7.30^{a}± 0.04
	15	7.00^{a}± 0.03	7.25^{a}± 0.10	7.05^{b}± 0.02	7.05^{a}± 0.04	6.80^{b}± 0.08	6.75^{b}± 0.08
	30	6.70a± 0.16	6.90^{c}± 0.01	7.00^{cb}± 0.04	6.60^{c}± 0.06	6.50^{c}± 0.04	6.45^{c}± 0.14
CD($p<0.05$)		0.30	0.24	0.20	0.43	0.15	0.25

All values are Mean ± SD. Values in a row with different superscript letters are significantly different, $P < 0.05$.
Type II: 40:30:30 (WF: BF: LFSF) TII A: Type II flour with ARP@ 3%, T II C - Type II flour with ARP@ 5%

The *ladoos* were stored in thermally sealed high density polyethylene bags for a period of 30 days at room temperature. The mean scores for sensory quality of *ladoos* on storage are presented in table 5. A significant difference was observed in the texture, taste, flavour and overall acceptability of sweet balls at 30th day as compared to the fresh samples in control as well as test samples in control as well as test *ladoos*. However, the scores of appearance and colour were not affected significantly in control as well as test samples. All the samples were found to be acceptable falling in the range of liked moderately. However, in group TII C with maximum level of incorporation of *ashwagandha* (5%) a significant decrease was found in the sensory scores from 0 to 30 days as the scores changed from the range of liked moderately to like slightly. Therefore, the TII C *ladoos* are best consumed within 15 days whereas T II A and control *ladoos* can be stored for upto 30 days.

Conclusion

The present investigation demonstrated that cereal-legume blend in appropriate proportions can be utilized to prepare nutritious sweets. The sensory evaluation of the *ladoos* revealed that the variation in proportion of cereal-legume affected the sensory scores of the *ladoos* more than the level of *ashwagandha* incorporation since it was a sweet product and slight bitter taste of *ashwagandha* was masked by sweetness of jaggery. Among different variations, T II *ladoo* with WF: BF: LFSF in the ratio of 40:30:30 had highest sensory acceptability. The control had highest mean scores in majority of sensory parameters except for colour in which the test products scored higher. There were no significant differences found in the sensory attributes of control and test *ladoos* in the selected treatment TII, which showed that *ashwagandha* supplementation did not affect the overall sensory acceptability of the *ladoos* adversely and incorporation till the level of 5% was acceptable. Shelf life study showed that the sensory scores in TII C *ladoos* decreased significantly from 0 to 30 days indicating that increase in level of *ashwagandha* affected the taste and flavor of the product adversely. The shelf life study indicated that the *ladoos* can be stored for 30 days except for TIIIC which is best consumed within 15 days.The shelf life of these *ladoos* can be further increased by increasing the jaggery and fat content.

The results of nutritional evaluation revealed that *ashwagandha* supplementation improved the crude fat, crude fiber, total dietary fiber and mineral content of the *ladoos*. The mineral content of the test products improved significantly with increase in level of *ashwagandha* supplementation in comparison to the control. Results showed that supplementation with *ashwagandha* further increased the nutritional value of the product. The study therefore suggests that *ashwagandha* supplementation can be used effectively as a source of value addition in sweet preparations to increase the fat, fiber and mainly the micronutrient content in addition to imparting beneficial medicinal properties.

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