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Development and Quality Evaluation of Cereal-Legume based Biscuits Enriched with Ashwagandha (*Withania somnifera*) Root Powder

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Abstract

The present study was carried to utilize ashwagandha root powder for the enrichment of biscuits prepared from variations of cereal-legume blend and to evaluate their quality. Three variations of control biscuits with different level of cereals, mainly barley and wheat flour and legume-soy flour (without ashwagandha) 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 biscuits made of wheat flour, barley flour and soy flour in the ratio of 30:45:25. Since no significant difference was found in the acceptability of biscuits containing 3%, 4 % and 5% ashwagandha in the selected variation, therefore the biscuit with minimum (3%) and maximum level (5%) of ashwagandha were selected for further nutritional evaluation. The percentage increase in protein, crude fat, energy value and crude fiber improved with increase in level of ashwagandha. The mineral content of the biscuits also improved significantly ($p<0.05$) with the increase in the level of ashwagandha. The changes in sensory quality of the selected biscuits, on storage demonstrated that there were no significant differences in scores of taste and overall acceptability of the biscuits upto 60 days. The investigation thus suggests that ashwagandha root powder upto a level of 5% can be added in snack products like biscuits for enrichment and value addition as a functional component to increase the energy value, protein, fat, fiber and mainly the mineral content of the product as well as imparting medicinal properties to the products.

Keywords: Ashwagandha, (*Withania somnifera*), value added biscuits, mineral, functional foods, enrichment.

INTRODUCTION

The use of medicinal plants as food alternative traces back to ancient human civilizations. The medicinal properties of plant species have made significant contribution in the formulation of many traditional herbal therapies. Medicinal plants play a significant part in providing primary health care services to rural people and are used by about 80% of the marginal communities around the world[13]. Each medicinal plant species has its own nutrient composition in addition to having phytochemicals with pharmacologic significance.

Biscuits are a popular food eaten by both children and adults. However, biscuits are typically high in both fat and refined sugar and have been identified as a food contributing to negative health [19]. Nutritional and medicinal qualities of biscuits can be enhanced by using cereal –legume blends and enrichment with ingredients such as medicinal plant extract or powder [16].The basic ingredient of biscuits is either refined wheat flour or wheat flour. 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 contains about 38 to 40 per cent protein of superior quality and 18 to20 per cent oil[15]. Barley is a major cereal grain with many health benefits. Barley β-glucan helps to alleviate dyslipidemia[9] and reduce CVD [5].Regular consumption of barley is associated with reduced risk of various diseases, such as colonic cancer[10] and high blood pressure[6]. Ashwagandha (*Withania somnifera*), an important herb in Ayurveda, is considered as an excellent rejuvenator, a general health tonic and a cure for a number of health complaints. It is a diuretic, analgesic[17] anti-inflammatory, [1] antistress[4] antioxidant[8] anticonvulsive[12] and an excellent adaptogen. Ashwagandha exhibits a variety of therapeutic effects with little or no associated toxicity[3, 13]. 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 process and utilize ashwagandha for enrichment of biscuits made from variations in barley, low fat soy wheat followed by sensory, nutritional and shelf life evaluation.

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 (Figure1). 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 for better shelf life due to decrease in amount of fat. All other ingredients for preparation of food products were purchased from the local market of Pantnagar. Barley grains were soaked prior to milling to obtain a fine powder and stored in air tight plastic container till further use.

Product Development: The biscuits were made out of flour of wheat, low fat soy flour and barley flour, according to the traditional cremory method[18](Figure 2).The control products were prepared with the flour mixture in various combinations. 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%

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%

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 addition (ARP i.e. 3, 4 and 5 g)

Sensory evaluation: The biscuits were evaluated for sensory quality by a semi-trained panel of 10 members with A 9 point hedonic scale [7] 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. For evaluating storage stability biscuit with best nutritional value were stored in high density polyethylene bags and stored for 2 months at room temperature (28-32^{0}C) and evaluated at an interval of 30 days and compared to fresh samples.

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 [14].

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

Sensory Scores of the Biscuits: The data pertaining to effects of incorporation of various levels of ashwagandha on sensory attributes of cereal-legume based biscuits variants has been shown in Table 1. Type I biscuits fell in the category of 'liked slightly and type II in the category of liked slightly-like moderately and type III was liked moderately –like very much. A significant difference was obtained in the mean sensory scores of all the three types of biscuits which showed that the sensory scores were affected more by the type of flour blends rather than the level of ashwagandha. It was observed that as the level of barley increased the sensory scores improved as biscuits TIII with maximum amount of barley flour (45%) had highest scores, since the barley grains were soaked prior to milling, unlike wheat and soy flour which improved the texture and taste of the biscuits.

In all the three types of biscuits, the test samples had higher scores in appearance, colour and texture. This was due to the reason that the control samples consisted of higher percentage of roasted low fat soy flour which imparted a brown colour and hard texture to the biscuits that affected the colour scores adversely. In test products the flour were replaced by ashwagandha powder with cream colour that improved the colour and appearance of test products. There were no significant difference in the scores of taste and overall acceptability of control and test biscuits in all the treatments. Among all the treatments TIII biscuits had highest scores of overall acceptability. Therefore, TIII group was selected for further evaluation. Among type III group no significant difference was found in the mean sensory scores of overall acceptability between and TIIIA, TIIIB and TIIIC containing 3%, 4% and 5% of ashwagandha. Therefore, TIIIA and TIIIC with minimum (3%) and maximum (5%) of ashwagandha supplementation were selected for further nutritional evaluation to find out the effect of ashwagandha on the nutritional composition of the biscuits.

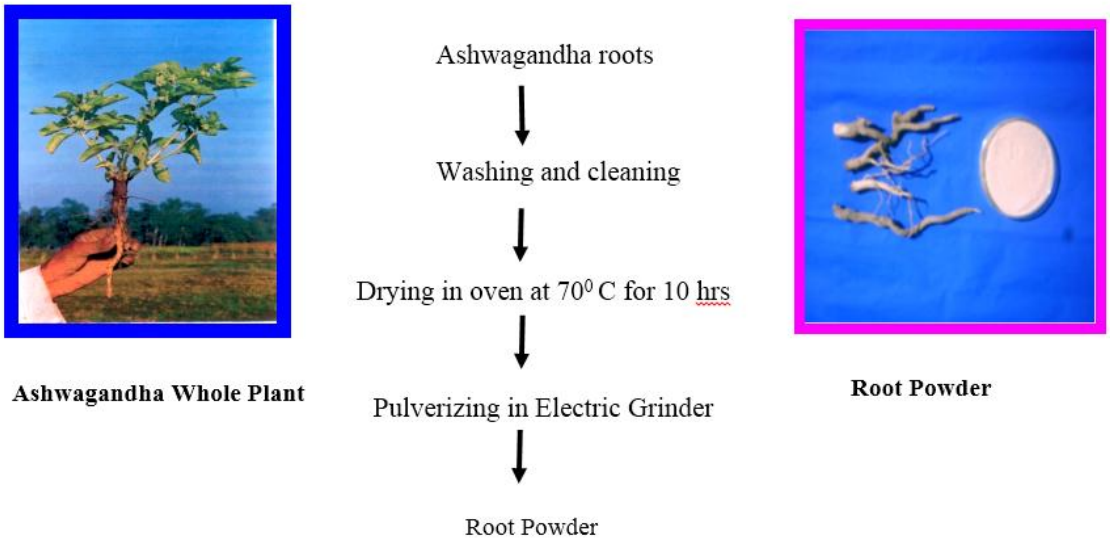

Fig. 1 Flow chart for preparation of ashwagandha root powder

Control **Test Biscuit**

Flour Mix, Flour Mix + ARP → Premixing (Fat and sugar) → Mixing (cream, baking powder, milk powder, ammonium bicarbonate) → Sheeting(3-5mm thick) → Molding → Baking → Cooling → Packaging (HDPE)

Fig. 2 Flow chart for preparation of Biscuits

Table 1. Mean Scores of Sensory Evaluation of Biscuits

Treatments	Appearance	Colour	Texture	Taste	Flavour	Overall acceptability
TI (Control)	$6.80^{a} \pm 0.03$	$6.80^{a} \pm 0.03$	$6.70^{a} \pm 0.07$	$6.65^{a} \pm 0.07$	$6.80^{a} \pm 0.06$	$6.85^{a} \pm 0.07$
TIA	$6.78^{a} \pm 0.10$	$6.85^{a} \pm 0.07$	$6.70^{a} \pm 0.05$	$6.60^{a} \pm 0.05$	$6.70^{b} \pm 0.05$	$6.83^{a} \pm 0.07$
TIB	$6.80^{a} \pm 0.05$	$6.96^{a} \pm 0.10$	$6.75^{b} \pm 0.06$	$6.60^{a} \pm 0.06$	$6.70^{b} \pm 0.03$	$6.85^{a} \pm 0.07$
TIC	$6.85^{a} \pm 0.11$	$7.00^{a} \pm 0.04$	$6.80^{b} \pm 0.03$	$6.63^{a} \pm 0.13$	$6.65^{c} \pm 0.06$	$6.80^{a} \pm 0.04$
CD ($p<0.05$)	0.25	0.26	0.04	0.06	0.02	0.06
TII (Control)	$6.90^{a} \pm 0.06$	$7.10^{b} \pm 0.10$	$6.90^{a} \pm 0.03$	$7.80^{a} \pm 0.11$	$7.25^{a} \pm 0.11$	$6.95^{a} \pm 0.67$
TIIA	$7.00^{a} \pm 0.14$	$7.10^{b} \pm 0.13$	$6.90^{a} \pm 0.05$	$7.82^{a} \pm 0.10$	$7.20^{a} \pm 0.11$	$6.95^{a} \pm 0.10$
TIIB	$7.00^{a} \pm 0.66$	$7.20^{b} \pm 0.17$	$6.95^{a} \pm 0.06$	$7.83^{a} \pm 0.16$	$7.20^{a} \pm 0.11$	$7.05^{a} \pm 0.03$
TIIC	$7.30^{a} \pm 0.14$	$7.28^{a} \pm 0.45$	$7.05^{b} \pm 0.07$	$7.80^{a} \pm 0.37$	$7.18^{a} \pm 0.67$	$7.00^{a} \pm 0.12$
CD ($p<0.05$)	0.10	0.07	0.10	0.10	0.10	0.05
T III (Control)	$7.30^{a} \pm 0.67$	$7.43^{a} \pm 0.67$	$7.33^{a} \pm 0.17$	$7.45^{a} \pm 0.67$	$7.38^{a} \pm 0.67$	$7.45^{a} \pm 0.47$
TIIIA	$7.33^{a} \pm 0.05$	$7.45^{a} \pm 0.08$	$7.30^{a} \pm 0.10$	$7.40^{a} \pm 0.05$	$7.35^{a} \pm 0.08$	$7.45^{a} \pm 0.05$
TIIIB	$7.40^{b} \pm 0.10$	$7.50^{b} \pm 0.06$	$7.35^{a} \pm 0.07$	$7.42^{a} \pm 0.06$	$7.30^{a} \pm 0.10$	$7.43^{a} \pm 0.10$
TIIIC	$7.40^{b} \pm 0.06$	$7.50^{b} \pm 0.04$	$7.35^{a} \pm 0.05$	$7.40^{a} \pm 0.06$	$7.30^{a} \pm 0.04$	$7.43^{a} \pm 0.05$
CD ($p<0.05$)	0.07	0.06	0.08	0.04	0.08	0.07

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

Proximate Composition of the Biscuits: Table 2.depicts the data showing the results of the proximate composition of TIIIA and TIIIC biscuits as compared to the control. The carbohydrate content of control biscuits TIII was more (59.51%) than TIIIA (59.46) and TIIIC (59.33) which was due to presence of higher level of cereal flours in the control. The energy value of TIII biscuits was 441.27 Kcal/100 g which increased to 442.90 Kcal/100 g and to 444.14 Kcal/100g in TIIIA and TIIIC biscuits as compared to control. The energy value, crude fat, total ash and crude fiber content were found to improve with increase in level of ashwagandha enrichment

Table 2. Proximate Composition of Value added Biscuits (g/100 g)

Products (Biscuits)	Energy (Kcal/100g)	Crude Protein	Crude Fat	Total ash	Crude Fiber	Carbohydrate
TIII(Control)	$441.27^{a} \pm 1.49$	$12.15^{a} \pm 0.12$	$17.23^{a} \pm 0.10$	$1.57^{a} \pm 0.17$	$4.27^{a} \pm 0.25$	$59.51^{a} \pm 0.50$
TIIIA	$442.90^{a} \pm 2.08$	$12.25^{a} \pm 0.10$	$17.37^{a} \pm 0.15$	$1.60^{a} \pm 0.02$	$4.60^{a} \pm 0.49$	$59.46^{a} \pm 0.82$
TIIIC	$444.14^{b} \pm 2.60$	$12.55^{b} \pm 0.11$	$17.50^{a} \pm 0.05$	$1.77^{b} \pm 0.05$	$4.75^{a} \pm 0.16$	$59.33^{a} \pm 0.47$
CD($p<0.05$)	3.38	0.12	0.31	0.20	0.99	0.75

All values are Mean ± SD. Values in a row with different superscript letters are significantly different, $P < 0.05$. Type III: 30:45:25 (WF: BF: LFSF) TIIIA: Type III flour with ARP@ 3%, TIII C - Type III flour with ARP@ 5%

Mineral Composition of the Biscuits: The mineral composition of the biscuits is presented in Table 3. Results indicate that the mineral content (mg/100g) of TIIIA and TIIIC biscuits was higher as compared to the control TIII. A significant difference was found in the mineral content of control and test biscuits ($p<0.05$), except for copper. The value of iron content (mg/100g) of TIIIA was 1.93 which increased to 2.39 (23.8%) in TIIIA and to 2.55 in TIIIC (32.1%) increase from control. The zinc content of control biscuits was 1.51 mg which increased to 1.55 mg in TIIIA (2.64%) and 1.60 mg to TIIIC (3.22%). The value for magnesium content (mg/100g) of control biscuits was 58.95 which increased to 59.30 (0.76%) in TIIIA and 60.90 in TIIIC (3.30%) 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 TIIIC with 5% ashwagandha which clearly indicated that incorporation of ashwagandha improved the mineral content of the biscuits.

Table 3. Mineral Composition of the Value added Biscuits (mg/100g)

Products (Biscuits)	Iron	Copper	Magnesium	Zinc	Sodium	Manganese
TIII	$1.93^{a} \pm 0.05$	$0.21^{a} \pm 0.06$	$58.95^{a} \pm 0.15$	$1.51^{a} \pm 0.04$	$3.80^{a} \pm 0.10$	$0.80^{a} \pm 0.01$
TIIIA	$2.39^{b} \pm 0.03$	$0.24^{a} \pm 0.02$	$59.40^{b} \pm 0.43$	$1.55^{a} \pm 0.03$	$15.6^{b} \pm 0.06$	$0.82^{b} \pm 0.02$
TIIIC	$2.55^{c} \pm 0.05$	$0.29^{a} \pm 0.02$	$60.90^{c} \pm 0.03$	$1.60^{b} \pm 0.05$	$13.80^{c} \pm 0.03$	$0.85^{c} \pm 0.01$
CD($p<0.05$)	0.07	0.10	0.48	0.06	0.14	0.03

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

Type III: 30:45:25(WF: BF: LFSF), TIIIA: Type III flour with ARP@ 3%, TIIIC -Type III flour with ARP@ 5%

Table 4. Changes in Sensory Scores of selected Biscuits during storage period.

Biscuit	Days	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
TIII	0	$7.30^{a}\pm 0.17$	$7.43^{a}\pm 0.09$	$7.33^{a}\pm 0.07$	$7.45^{a}\pm 0.10$	$7.38^{a}\pm 0.07$	$7.45^{a}\pm 0.10$
	30	$7.20^{a}\pm 0.10$	$7.23^{a}\pm 0.07$	$7.00^{a}\pm 0.10$	$7.25^{a}\pm 0.07$	$7.33^{a}\pm 0.10$	$7.25^{a}\pm 0.07$
	60	$7.00^{a}\pm 0.11$	$7.00^{b}\pm 0.11$	$6.90^{b}\pm 0.09$	$7.00^{b}\pm 0.06$	$7.00^{a}\pm 0.06$	$7.20^{a}\pm 0.17$
		0.30	0.25	0.33	0.26	0.40	0.50
TIIIC	0	$7.40^{a}\pm 0.08$	$7.50^{a}\pm 0.04$	$7.35^{a}\pm 0.05$	$7.40^{a}\pm 0.09$	$7.30^{a}\pm 0.04$	$7.43^{a}\pm 0.15$
	30	$7.30^{a}\pm 0.05$	$7.00^{a}\pm 0.16$	$7.33^{a}\pm 0.06$	$7.25^{a}\pm 0.16$	$7.25^{a}\pm 0.05$	$7.25^{a}\pm 0.13$
	60	$7.00^{a}\pm 0.09$	$6.90^{a}\pm 0.08$	$6.80^{b}\pm 0.09$	$6.80^{b}\pm 0.10$	$7.00^{a}\pm 0.08$	$7.20^{a}\pm 0.18$
CD ($p<0.05$)		0.33	0.58	0.28	0.25	0.30	0.28

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

Changes in Sensory Scores of Selected Biscuits during Storage

The data on storage stability is presented in Table 4. Since TIIIC biscuits with 5% ashwagandha had highest proximate and mineral content values, therefore TIIIC biscuits were selected for storage stability study. The data revealed that the scores of texture and flavor of the biscuits decreased significantly ($p<0.05$) from day 0 to 60th day. Whereas no significant changes were observed in the scores of taste and overall acceptability even on 60th day and the range remained between liked moderately-very much.

CONCLUSION

In the present investigation, sensory evaluation revealed that ashwagandha supplementation improved the appearance, colour and texture of the product due to replacement of flour containing LFSF which imparted a brown color to the products. Ashwagandha supplementation till the level of 5% was found to be acceptable. Nutritional evaluation revealed that ashwagandha incorporation improved the energy value, protein, crude fat, crude fiber and mineral content of the biscuits. The mineral content of the test products improved significantly with increase in level of ashwagandha enrichment in comparison to the control. The storage study demonstrated that the biscuits can be consumed upto 60 days although best scores in all sensory parameters were observed upto a storage period of 30 days. Therefore the study suggests that ashwagandha, after suitable processing can be used effectively as a source of enrichment and value addition in biscuits along with cereals and legumes to increase the nutritional quality and impart beneficial medicinal properties.

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