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Efficacy of blanching in removing bitter aftertaste, nutrient retention, and saponins of *Asparagus racemosus* (Willd.) root powder

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Abstract

Asparagus racemosus (Willd.) has excellent galactogogue and antioxidant activity, and hence has been found very effective in improving lactation performance and being a natural preservative in extending the shelf-life of food products. However, it is endowed with a bitter aftertaste, which limits its utilization in the food industry. Efforts have been made to remove the bitter aftertaste of *A. racemosus* powder and to enhance mineral bioaccessibility through blanching. Blanching of *A. racemosus* roots was done at various time and temperature combinations, *i.e.*, 80ºC, 90ºC, and 100ºC temperatures for 5, 10, and 15 min, respectively. The taste of the developed powder with or without blanching was analysed by a panel of 30 semi-trained judges. The effect of blanching on saponins, antioxidants, nutrient contents, and mineral bioaccessibility was analysed using standard methods. Blanched root powder (80ºC for 15 min) had higher total soluble sugars (35.66%) and retained maximum amounts of antioxidants (71.86%) and saponins (5.30%). Blanching at 80ºC for 15 min, developed a mildly sweet aftertaste in the powder and removed bitterness completely. The blanched root powder contained 6.08, 12.67, and 18.75 per cent of soluble, insoluble, and total dietary fibre, respectively. Blanching increased the content of the total and non-reducing sugars significantly in the developed powder. Total calcium, iron, and zinc were found to be 103.24, 26.85, and 1.96 mg/100 g, respectively, in blanched root powder and the per cent *in vitro* bioaccessibility of these minerals were 53.35, 11.66, and 19.39 per cent, respectively. Blanching of *A. racemosus* roots at 80ºC for 15 min was highly effective in removing bitter aftertaste and better retention of antioxidants and saponins.

1. Introduction

Asparagus racemosus (willd.) is a perennial shrub belonging to the family Asparagaceae. It is an indigenous medicinal plant of the South Asian continent. Its medicinal properties have been reported in traditional systems of medicine and have been utilized for primary healthcare of people since time immemorial. Mostly the roots (powdered or extracted) have been used for medicinal purposes under the popular local name of 'Shatavari or Shatavar'. The roots are fleshy, whitish brown, and slightly sweet, nevertheless, the dried powder is endowed with a slightly bitter aftertaste.

The chief biochemical constituents identified in *A. racemosus* root powder (ARRP) are steroidal saponins (Shatvarin I to VI), oligospirostanoside (immunoside), polycyclic alkaloid (aspargamine), isoflavones, racemosol, racemofuran, mucilages-polysaccharides, flavonoids (quercitin), sterols (sitosterol) and kaempfrol along with sarsapogenin (Acharya *et al*., 2012; Alok *et al*., 2013). These constituents exhibit abundant physiological, immuno-modulatory, and stimulating actions on the body, and hence cure several disorders. This herb is highly effective in relieving problems associated with the female reproductive system (Kumar *et al*., 2008; Patil *et al*., 2022). Therefore, it is called the 'women's herb' blessed to cure female problems. In recent years, it has become the most important ingredient to be added to female health tonics. *A. racemosus* being a known source of phytoestrogens, has been found effective in reducing adverse menopausal symptoms such as hot flushes, night sweats, palpitations, insomnia, and anxiety. In a clinical trial done on 450 patients, it was reported that regular use of *A. racemosus* containing capsule during the antenatal period enhanced the fetal weight and fetal outcome and decreased the incidence of perinatal deaths. The incidence of gestational pre-eclampsia and hypertension was also decreased after its administration (Bhosle *et al*., 2003).

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A. racemosus root possesses a strong antioxidant activity due to the presence of racemofuran, asparagamine and racemosol (Wiboonpun *et al*., 2004). The possible antioxidant effects of crude extract and polysaccharides fraction of *A. racemosus* against membrane damage were examined in rat liver mitochondria (Kamat *et al*., 2000). Even at a very low concentration, the polysaccharides fraction was highly pronounced against lipid peroxidation, while that of crude extract was more effective in preventing protein oxidation.

In the food processing industry, *A. racemosus* may be used as a novel natural preservative to enhance the shelf-life of perishable and semi-perishable food products. Meat products containing ARRP

(0.25, 0.50, and 0.75 %) as a preservative indicated a significant effect on the lipid oxidative stability and storage quality without compromising the sensorial characteristics (Noor *et al*., 2017). ARRP (1%) was explored as a preservative in 'burfi' preparation and oxidative rancidity parameters were analysed during storage. 'Burfi' containing ARRP had significantly lower fat acidity, free fatty acid, and water activity than that of control 'burfi' (Saini, 2008). The potential of Shatavari root extract was also evaluated as a preservative in ghee against oxidation. Aqueous and ethanolic extracts of ARRP significantly retarded the deterioration of ghee as compared to control (Pawar *et al*., 2012). As the food industry is still missing out on the growing market for healthy ageing, ARRP can be a potent ingredient for such products. Consumers are health conscious nowadays and demand functional ingredients-based products for instance women to boost their lactation performance are curious to boost it in natural ways. ARRP-supplemented tonics and food products along with extended shelf-life may provide them a window of choice. *A. racemosus*, a highly beneficial herb packed with abundant medicinal properties has not been fully utilized in the industrial market due to its bitter aftertaste.

Blanching is a practical approach to producing high-quality value-added products that involves halting of cooking by immersing food in chilled water after heating at a particular temperature and time duration (Salvador-Reyes and Paucar-Menacho, 2019). It slows down the enzymatic actions, reduces bitterness and other heat-labile pathogens, inactivates endogenous toxic factors present in raw food materials and, therefore enhances palatability and nutrients in foods (Egbuonu and Nzewi, 2016). In a previous study, the blanching of bitter orange peels at

85^{0}C for 60 min reduced the bitter flavanones such as naringin, neohesperidin, and neoeriocitrin by 48 per cent (Benzid *et al*., 2015). Keeping in view the super effects of blanching this study was planned to develop *A. racemosus* root powder with better nutrient retention, more appealing colour, and no bitter aftertaste.

2. Material and Methods

2.1 Procurement of materials and reagents

For chemical analysis, protease, α-amylase, pepsin, pancreatin, and 2,2-diphenyl-1-picrylhydrazyl were purchased from Sigma-Aldrich, New Delhi. Sulphuric acid, hydrochloric acid, petroleum ether (boiling point 60-80°C), n-butanol, ethanol (75% and absolute), methanol, acetone, nitric acid, perchloric acid, anthrone, arsenomolybdate, glucose standard, EDTA and sodium phytate were obtained from HiMedia, Mumbai. Boric acid, 2,2-bipyridyl, calcium chloride, hydroxylamine-hydrochloride, diethyl ether, sodium hydroxide, and sodium chloride were purchased from Merck India, New Delhi. Trolox, was purchased from CDH Chemicals, New Delhi.

Fresh *A. racemosus* roots were procured from Medicinal, Aromatic and Underutilized Plants Section, Department of Genetics and Plant Breeding, CCSHAU, Hisar in a single lot.

2.2 Study design

A. racemosus roots were blanched at 80°C, 90°C, and 100^{o}C temperature for 5, 10 and 15 min. The contents of saponins, total soluble sugars, starch, and antioxidant activity were compared within the given treatments, and the best powder was selected for taste and nutrient analysis. It was analysed for proximate composition, dietary fibre profile, and total and bioaccessible minerals (*in vitro*) in triplicate which was compared with unblanched powder.

2.3 Development of *A. racemosus* root powder

The process of development of *A. racemosus* root powder using blanching treatments has been described in the flow diagram (Figure 1). The time and temperature of blanching were maintained using a stopwatch and laboratory thermometer, respectively. The unblanched powder was prepared similarly while skipping steps four and five explained in Figure 1.

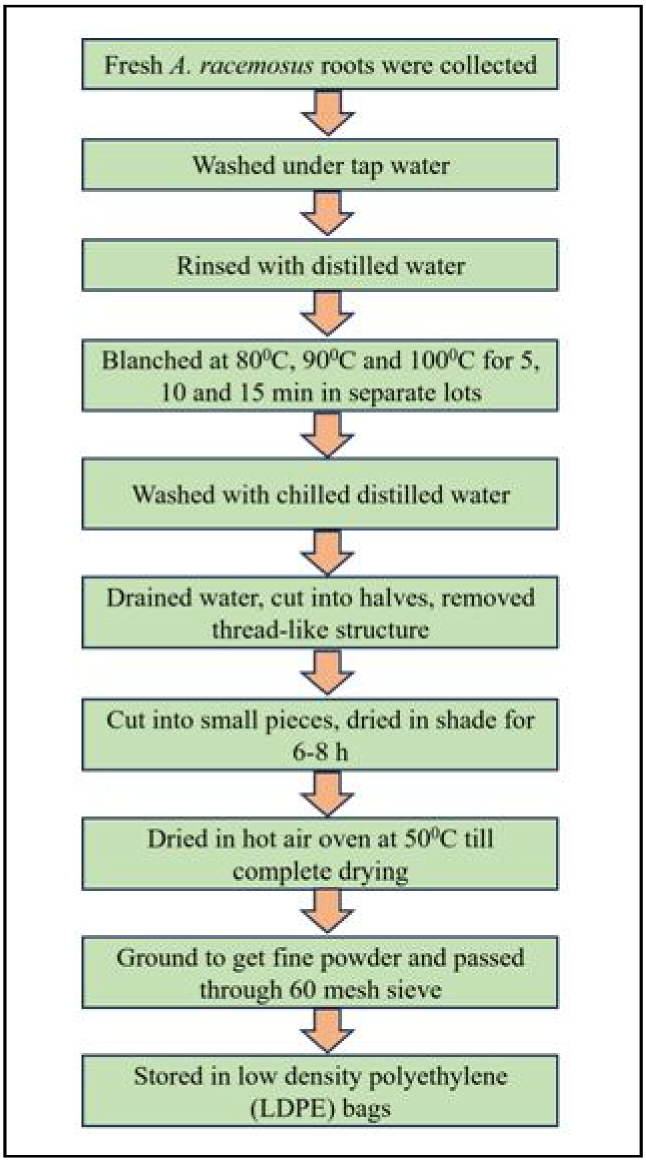

Figure 1: Processing and development of *A. racemosus* root powder.

2.4 Saponins, antioxidants, sugar analysis

Saponins were quantified in ethanolic extract using the gravimetric method reported by Ejikeme *et al*. (2014). The sample extraction for antioxidant activity was done using 80 % methanol using the methodology earlier mentioned by Serrano *et al*. (2007). The antioxidant activity of the extracts, as scavenging activity of the stable DPPH free radical, was determined by the method earlier described by Tadhani *et al*. (2009). Total soluble sugars in the methanolic extract were extracted by the method mentioned earlier (Rani and Grewal, 2009). The absorbance of sample mixed anthrone was read at 625 nm in Spectronic-21 against a suitable blank. For the estimation of reducing sugars, 1 ml extract was taken in a graduated tube. 1 ml mixed copper reagent was added and then heated for 20 min in a boiling water bath. To this, 1 ml arsenomolybdate reagent was added, mixed thoroughly, and diluted to 25 ml with distilled water. A stable blue colour quickly appeared which was read at 520 nm against a suitable blank. The amount of reducing sugar was then determined by referring to the glucose standard curve. Non-reducing sugars were calculated as the difference between the amounts of total soluble sugars and reducing sugars. For starch detection, root residues were extracted in perchloric acid (52%) and analysed by the method mentioned earlier (Rani and Grewal, 2009).

2.5 Taste

The taste of the developed powder was analysed sensorily by a panel of 30 semi-trained judges on a 9-point hedonic scale comprising of faculty, research associates, and Ph.D. scholars of the Department of Foods and Nutrition, CCSHAU, Hisar explained earlier by Verma *et al*. (2022)

2.6 Nutrient analysis

Proximate composition (moisture, crude protein, crude fat, crude fibre, and ash) was analysed using standard methods of AOAC (2010). Moisture was analysed using automatic moisture analyser (ANDMX-50, Japan), Nitrogen content was digested and distilled using Kjeldahl Kel Plus (KES06LR, Pelican, Chennai, India), ether extraction to analyse fat content was conducted using Socs Plus (SCS08RTS, Pelican, Chennai, India), crude fibre as acid and alkali resistant and dietary fibre constituents were investigated using enzymatic with Fibra plus (FES08A DLS TS, Pelican, Chennai, India) and ash was estimated in a muffle furnace (KHERA Instruments, India). Samples were analysed for total, soluble, and insoluble dietary fibre using the enzymatic method earlier explained by Rani *et al*. (2022). The acid-digested (HNO_3:$HClO_4$; 5:1 v/v) samples were evaluated for total calcium, iron, and zinc by atomic absorption spectrophotometer 240 FS (Australia) using the methodology explained earlier by Jyoti *et al*. (2022). *In vitro* bioaccessibility of calcium, zinc, and iron was analysed using the enzymatic method as earlier mentioned by John *et al.* (2020).

2.7 Statistical analysis

Statistical analyses were conducted using SPSS for Windows version 19. One-way ANOVA with LSD test was performed to analyse the effect of various time and temperature combinations of blanching on taste, saponins, antioxidants, and sugars. A paired *t*-test was used to differentiate the nutrient contents between blanched and unblanched samples. Results were expressed as a means ± SE and means were accepted as significantly different at a 95 % confidence interval; $p<0.05$. *In vitro* bioaccessibility of minerals was expressed in per cent.

3. Results

3.1 Soluble sugar

The blanched powder had higher TSS, RS, and NRS however the lower contents of starch. The highest TSS, RS, and NRS were found to be in powder developed with roots blanched at 80°C for 15 min, consequently the same powder had the lowest starch (Table 1). A clear trend was observed for an increase in sugars with the increase in time duration at 80°C temperature, however, a decrease was observed with further increments in temperature.

Table 1: Sugars and starch of *A. racemosus* root powder (%, on dry weight basis)

Treatment	TSS	RS	NRS	Starch
Unblanched	31.18 ± 0.85^{bc}	5.33 ± 0.23^{bc}	25.85 ± 0.45^{bc}	26.35 ± 0.62^{a}
Blanched at 80°C				
T_1	32.16 ± 0.45^{b}	6.04 ± 0.71^{b}	26.12 ± 0.89^{b}	23.92 ± 0.25^{b}
T_2	33.90 ± 0.78^{b}	6.15 ± 0.43^{b}	27.75 ± 0.61^{a}	22.18 ± 0.39^{bc}
T_3	35.66 ± 0.61^{a}	6.76 ± 0.17^{a}	28.90 ± 0.50^{a}	20.85 ± 0.35^{c}
Blanched at 90°C				
T_1	31.08 ± 0.68^{bc}	5.72 ± 0.22^{b}	25.36 ± 0.68^{c}	24.05 ± 0.36^{a}
T_2	30.52 ± 0.53^{b}	4.92 ± 0.21^{b}	25.60 ± 0.47^{a}	23.56 ± 0.54^{b}
T_3	30.12 ± 0.69^{b}	4.58 ± 0.65^{a}	25.54 ± 0.43^{a}	21.29 ± 0.69^{c}
Blanched at 100°C				
T_1	29.20 ± 0.81^{c}	4.32 ± 0.52^{b}	25.88 ± 0.25^{d}	25.18 ± 0.45^{a}
T_2	28.95 ± 0.48^{c}	3.90 ± 0.26^{b}	25.05 ± 0.49^{c}	24.23 ± 0.39^{a}
T_3	28.86 ± 0.75^{bc}	3.50 ± 0.21^{b}	25.36 ± 0.25^{bc}	23.83 ± 0.31^{b}

Values are Mean ± SE of three independent determinations.
T_1: 5 min; T_2: 10 min; T_3: 15 min

The starch content of *A. racemosus* powder was decreased with an increase in temperature during blanching and ranged from 20.85 to 26.25 per cent, being highest in unblanched powder (Table 1).

3.2 Saponins and antioxidants

Saponins and antioxidants are the bioactive constituents present in abundance in *A. racemosus* roots. A significant reduction was observed for both constituents during blanching. However, these were retained in substantial amounts (5.30 % and 71.86 %) in root powder developed using blanching treatment at 80°C for 15 min. The contents of saponins in *A. racemosus* root powder developed using various blanching treatments ranged between 3.69 to 5.86 per cent being highest in unblanched powder whereas lowest in roots powder blanched for 15 min at 100°C. On the other hand, contents of antioxidant capacity measured as DPPH had ranged between 65.86 to 76.57 per cent and that was observed maximum in unblanched root powder whereas minimum in powder developed using roots blanched at 100°C for 15 min.

Table 2: Saponins and antioxidants capacity of *A. racemosus* root powder (%, DM)

Treatment	Saponins	Antioxidants capacity (DPPH)
Unblanched	5.86 ± 0.03^a	76.57 ± 0.23^a
Blanched at 80°C		
T_1	5.13 ± 0.05^b	71.26 ± 0.42^a
T_2	5.12 ± 0.14^a	71.03 ± 0.56^a
T_3	5.30 ± 0.02^a	71.86 ± 0.14^a
Blanched at 90°C		
T_1	5.20 ± 0.03^b	70.29 ± 0.23^b
T_2	5.10 ± 0.08^b	70.02 ± 0.28^b
T_3	4.90 ± 0.08^b	69.86 ± 0.19^b
Blanched at 100°C		
T_1	4.15 ± 0.08^c	68.58 ± 0.65^b
T_2	3.90 ± 0.09^c	66.42 ± 0.39^b
T_3	3.69 ± 0.03^c	65.86 ± 0.47^b

Values are Mean ± SE of three independent determinations.
T_1: 5 min; T_2: 10 min; T_3: 15 min

3.3 Taste

Based upon the sugars and saponin retention at various time and temperature combinations of blanching, powder developed using blanching at 80°C for 15 min was used further for taste and nutritional evaluation. The mean score for the taste of unblanched powder was 5.6, therefore, it was categorised as "neither liked nor disliked" by the judges while considering its bitter aftertaste.

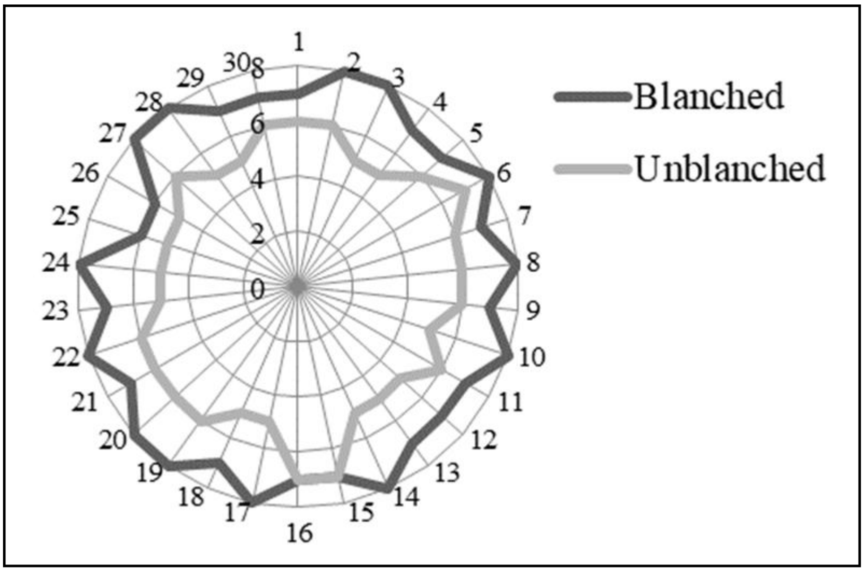

Figure 2: Sensory score of taste of A. racemosus root powder.

On the other hand, powder developed using blanching at 80ºC for 15 min was scored 7.3 and categorised as "liked moderately" and very much acceptable by the judge for its taste (Figure 2).

3.4 Nutrient contents

Results indicated that blanched root powder contained significantly ($p \leq 0.05$) higher moisture (90.82%) than that of unblanched (86.06%). Blanching had reduced the contents of crude fat and crude protein however; the effect was not found to be significant. The crude fat and crude protein contents of blanched and unblanched root powder were 0.73 and 0.61 per cent and 3.04 and 2.35 per cent, respectively.

Blanching at 80^{0}C for 15 min increased the content of fibre significantly ($p \leq 0.05$) (Table 3).

Total and available (*in vitro*) calcium, iron, and zinc were increased significantly ($p \leq 0.05$) during blanching (Table 3). Results indicated that unblanched root powder contained 94.6, 25.6, and 1.67 mg/100 g of calcium, iron, and zinc whereas the contents of the same were increased in blanched root powder, *i.e.*, 103, 26.8, and 2.0 mg/100 g, respectively. The per cent *in vitro* bioavailability of calcium, iron, and zinc in unblanched root powder was found to be 40.54, 9.10 and 13.77, per cent respectively, however, that was improved to 48.71, 11.66 and 19.39 per cent, respectively in blanched root powder.

Table 3: Effect of blanching on nutrient contents of *A. racemosus* root powder

Nutrients	Unblanched	Blanched at 80^{o}C for 15 min	*t*-value ($p \leq 0.05$)
Moisture (%)	86.0 ± 1.4	90.8 ± 1.1	7.9*
Crude fat (%)	0.73 ± 0.6	0.61 ± 0.1	2.2
Crude protein (%)	3.04 ± 0.5	2.35 ± 0.4	2.7
Crude fibre (%)	10.1 ± 0.8	11.7 ± 0.2	14**
Ash (%)	6.40 ± 0.1	8.02 ± 0.2	5.7*
Soluble dietary fibre (%)	7.8 ± 0.9	8.1 ± 0.2	7.8*
Insoluble dietary fibre (%)	10.8 ± 0.7	12.7 ± 0.1	22.8**
Total dietary fibre (%)	18.6 ± 0.8	20.7 ± 0.1	3.89
Calcium (Mg/100 g)	94.6 ± 1.8	103 ± 0.2	10.7**
Iron (Mg/100 g)	25.6 ± 0.7	26.8 ± 0.1	4.64*
Zinc (Mg/100 g)	1.67 ± 0.2	2.0 ± 0.2	11.7**
Available Ca (Mg/100 g)	38.3 ± 0.6(40.54)	50.2 ± 0.1(48.71)	48.7**
Available Fe (Mg/100 g)	2.3 ± 0.1(9.10)	3.1 ± 0.1(11.66)	8.02*
Available Zn (Mg/100 g)	0.23 ± 0.0(13.77)	0.39 ± 0.1(19.39)	7.21*

Values are Mean ± SE of three independent determinations.
** Significant at 1% level; * Significant at 5% level.
Values in parenthesis indicate per cent availability.

4. Discussion

In this study, results indicated that blanching had increased the contents of total soluble sugars in *A. recemosus* root powder. The results of total soluble sugars observed in the present study are in close proximity with the earlier finding (Dauda, 2014; Badwaik and Deka, 2015; Kachhadiya *et al.*, 2018; Szymanek *et al.*, 2020). Califano and Calvelo (1983), had analysed the effect of blanching on sugar retention in potatoes and revealed a 10 per cent increase in initial content. Generally, the blanching temperature has a negligible effect on the sugar content, due to its influence on the simultaneous mechanisms of generation and leaching into the blanching media (Szymanek *et al.*, 2020). In the present study, it was observed that with a further increase in temperature, the total sugar content becomes low and that is explained through higher leaching at high temperature. The retention of reducing sugars and fructo-oligosaccharides sugars in Yacon roots ranged from 70.1-87.4 and 68.2-109.7 per cent, respectively with varying degrees of temperature and time duration used during blanching (Campos *et al.*, 2016).

The reduced contents of starch upon blanching may be explained by the fact that thermal treatments modified the starch and also it gets gelatinized which may interfere with the testing protocol (Chen *et al.*, 2017). The trend for starch content during blanching observed in the present study is corroborated with the earlier findings (Gunartne and Hoover, 2002; Yao *et al.*, 2012; Tacer-Caba *et al.*, 2014).

Saponin is the major bioactive component found in *A. racemosus* roots that exhibits the most medicinal effect, however, it also imparts a slightly bitter taste. Other workers also found a decrease in the total antioxidant activity during blanching as has been observed in the present study (Tacer-Caba *et al.*, 2014; Chen *et al.*, 2017; Vinita, 2018). Concerning saponins, a similar effect of blanching was observed for *A. racemosus* roots (Noor *et al.*, 2017) and in other plant materials (Nwosu, 2010; Odufuwa *et al.*, 2013; Indriasari and Kumalaningsih, 2016; Lee *et al.*, 2019).

The very much acceptable taste of *A. racemosus* root powder after blanching might be attributed to the substantial increase in sugars and considerable loss of saponins. It was observed that the retention of sugars is most affected by the molecular size of sugar and duration of blanching (Song *et al.*, 2003).

Higher moisture in blanched powder might be materialized since plant tissues bear various changes in cell permeability and vacuole membrane upon high-temperature treatment, which leaches water-soluble nutrients and leads to more moisture retention (Rickman *et al*., 2007). During blanching soluble proteins might get leached in surrounding media (Yuan *et al*., 2009). A similar trend was observed by Saini *et al.* (2016) and Saranya *et al.* (2017). Mechanical disruption of cells during blanching might have resulted in better extraction of fibre in the present study. A similar increase in fibre content after blanching was observed by McDougall *et al.* (1996); Oulai *et al.* (2015); Saini *et al.* (2016). The contents of protein, ash, crude fibre, soluble, insoluble, and total dietary fibre observed in *A. racemosus* root powder in the present study are supported by Rajni *et al.* (2023).

Mineral stability during preparation and cooking is closely related to their solubility since they are present in bound form in plant tissue and hence are not readily lost by leaching. Moreover, significant loss of unstable compounds which get solubilised easily may increase the relative number of stable compounds. Our findings are close to earlier investigations (Lisiewska *et al*., 2009; S³upske, 2011; Aathira *et al*., 2017). Furthermore, the removal or destruction of anti-nutrients during blanching plays a significant role in improving the availability of minerals. Degradation of tannins and saponins in other plant material upon blanching has been observed by Saini *et al.* (2016) Saranya *et al.* (2017) and Aathira *et al.* (2017).

5. Conclusion

This study concluded that blanching of *A. racemosus* roots at 80ºC for 15 min increased the contents of sugars and retained maximum amounts of saponins and antioxidants. The blanched powder developed a mild sweet aftertaste and complete removal of bitter aftertaste was observed. Degradation of saponins during blanching had a positive impact on improving the taste of the developed powder. Saponin, the major bioactive component of *A. racemosus* was retained in substantial amounts in developed powder. Blanching has improved the dietary fibre and *in vitro* availability of major minerals i.e. calcium, iron, and zinc. The improved taste of root powder has increased its potential to be utilized in a variety of food products such as women's special biscuits, extruded products, pasta, bread, muffins, and beverages, and these with galactogogue activity or the products of special women herb. Products of super shelf-life may be developed using *A. racemosus* root powder due to its strong preservative nature.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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