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Nutritional analysis of *Asparagus racemosus* (Willd.) root powder and its efficacy in increasing prolactin level in lactating women

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Abstract

Asparagus racemosus (Willd.) has a rich history in traditional medicine and is known for its diverse therapeutic properties. This study presented a comprehensive nutritional analysis of *A. racemosus* root powder (ARP), emphasizing its potential implications in the field of phytomedicine. The present investigation involved the evaluation of various nutritional components, including proximate composition, mineral content, dietary fiber, and antioxidant profile of *A. racemosus* root powder and to evaluate its efficacy in increasing level of prolactin hormone responsible for healthy lactation. The findings revealed that *A. racemosus* root powder possessed a significant presence of essential nutrients, with notable amounts of crude fiber, calcium, iron, and antioxidants. The proximate composition indicated high crude fiber (10.59 %) content, highlighting the potential digestive health benefits associated with *A. racemosus* consumption. Additionally, the mineral analysis demonstrated noteworthy levels of calcium (178.48 mg/100 g) and iron (24.14 mg/100 g), suggesting potential implications for bone health and iron-deficiency anaemia management. Furthermore, the assessment of the antioxidant profile unveiled considerable antioxidant activity, indicating the role of *A. racemosus* in combating oxidative stress and associated ailments. These findings collectively suggest that A. racemosus root powder holds promise as a natural source of essential nutrients and bioactive compounds that could contribute to various therapeutic applications in the realm of phytomedicine. Intake of 10 g of powder for 90 days in lactating women had increased prolactin level significantly from 151.81 to 296.07 ng/ml. Given the increasing global interest in natural remedies and alternative medicine, the comprehensive nutritional analysis of *A. racemosus* root powder provides valuable insights into its potential role in promoting overall health and well-being.

1. Introduction

Herbal medicines are now commonly utilized in food and medicine purposes since they are less expensive, have fewer adverse effect and are more powerful than manufactured drugs (Mehrotra, 2021). *Asparagus racemosus* (Willd.) locally known as *Shatavri* is an ayurvedic herb belongs to family Asparagaceae and sub family Liliaceae (Sachan *et al*., 2012). It is mostly employed in Ayurveda and Unani systems of medicine (Bishnoi *et al*., 2018). The roots of *A. racemosus* are 30 to 100 cm long and 1 to 2 cm thick and pointed at both ends. Its plants do not require much watering. *A. racemosus* roots are bushy, light brown in colour and have a bitter and sweet flavour; however, powder from the dried roots has a little bitter after taste. Blanching of roots has been found effective in decreasing bitter after taste of *A. racemosus* root powder (ARP) while holding substantial amounts of saponins and antioxidants (Rani *et al*., 2020). *Asparagus*, widely dispersed throughout Asia and Africa. This plant, *A. racemosus*, holds great medicinal importance, especially in the tropical and subtropical regions of India, where it is a major element in various pharmacopoeias and traditional healthcare systems, including Ayurveda, Unani, and Siddha. *Shatavari*, renowned for its rich nutritional profile, contains essential components such as ascorbic acid, vitamin B_6, folic acid, rutin, saponin, and glutathione (Sun *et al*., 2005). In the sphere of Ayurveda, *A. racemosus* is often designated as a "rasayana," distinguished for its adaptogenic characteristics, assisting the body in acclimating to various stressors (Singh *et al*., 2023).

The major nutrients found in ARP (per 100 g) as determined by chemical analysis: 9.5 per cent of the sample was determined to be moisture, 3.55 g of ash, 2.47 g of protein, 0.11 g of fat, 2.5 g of crude fibre, 22 kcal of energy, 3.39 g of carbohydrate, 2.17 mg of iron, and 26 mg of calcium, respectively (Kumari and Gupta, 2016). The presence of bioactive components in *A. racemosus* is primarily responsible for its therapeutic effectiveness since they have a distinct physiological, immune-modulatory, and stimulating effect on the body (Kaur and Arora, 2009). *A. racemosus* has more than 50 bioactive compounds including isoflavones, polysaccharides, mucilage, racemosol and steroidal saponin (Sharma *et al*., 2013). Phytoestrogen compound saponins, such as Shatavarin I-IV, are found in large amount in the roots of *A. racemosus* (Singh *et al*., 2018). The primary active components of *A. racemosus* include steroidal saponin and flavonoids present in the roots, which are the main contributors to the estrogen regulating properties. (Alok *et al*., 2013). Flavonoids and saponin have ability to affect the endogenous production of estrogen. It helps pituitary gland to

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release gonadotropins (GnRH) that stimulate synthesis of estrogen in the ovaries.

Women experience several physical and psychological changes during their lifespan. Their reproductive health is extremely important for overall health, not just for childbearing but also for her development, menstrual cycle, maintaining menopause, and body hormone balance which depend on how the hypothalamus-pituitary-ovarian-endometrial axis interacts (Ganguly and Khakhlary, 2017). *A. racemosus*, a well-known female rejuvenative herb, is really thought to be the most beneficial for women in curing all female hormonal issues and is especially effective in improving female fertility (O Leary *et al*., 2021; Patil *et al*., 2022). The hormone levels in a woman's body at any particular moment are thought to be responsible for changes during their reproductive years. The roots of *A. racemosus* has an excellent remedy for many female problems including improving milk production and alleviating menopausal symptoms (Khan *et al*., 1991). Its roots and root extracts have been studied by a number of researchers, who discovered that it can improve lactational insufficiency in postpartum mothers (Shelukar *et al*., 2000). Various manufacturing companies produced *A. racemosus* in the form of tablets, capsules, sprinkles, granules or powder under the brand name *A. racemosus* (Pandey *et al*., 2018), Ricalax Lactare (Rowan, 2000) Emcure Galact, and Dabur Shatavari are few examples.

The use of *A. racemosus* in Ayurveda, has been described absolutely safe for long term use even during pregnancy and lactation. Systemic administration of higher doses of all extracts did not produce any abnormality in behavior pattern of mice and rat (Jetmalani *et al*., 1967). LD_{50} of the product lactare has not been assessed since it did not produce mortality even up to the oral dosage of 64 g/kg (Narendranath *et al*., 1986).

Keeping in view the diversified medicinal and nutritional benefits of *A. racemosus,* the current study was planned to analyse the nutritional and bioactive constituents of *A. racemosus* root powder as well as to evaluate its efficacy in increasing prolactin hormone level in lactating women.

2. Materials and Methods

2.1 Procurement and processing of *A. racemosus*

Fresh *A. racemosus* roots were obtained from the Medicinal, Aromatic, and Underutilized Plants Section at the Department of Genetics and Plant Breeding in CCSHAU, Hisar. For processing of *A. racemosus* root powder, the fresh roots were carefully separated from their bunch and thoroughly cleaned under flowing water to eliminate any impurities. To extend the shelf-life of the *A. racemosus* root powder, the roots underwent a blanching process at 80°C for 3 min. Following blanching, they were dried in a hot air oven at a controlled temperature of 60 ± 5°C. Once adequately dried, the *A. racemosus* roots were finely ground into a powder and sieved through a 60-mesh sieve for uniform texture (Figure 1). The resulting dry powder was then securely packed in a low-density polyethylene (LDPE) bag and stored in a hermetically sealed plastic container, ensuring its preservation and suitability for future applications.

Asparagus roots | Blanched and shredded *Asparagus* roots | *Asparagus* root powder

Figure 1: Unprocessed and blanched *A. recemosus* roots and *A. racemosus* roots powder.

2.2 Nutritional evaluation of *A. racemosus* root powder

The *A. racemosus* root powder underwent a comprehensive analysis to determine its proximate composition, adhering to the established procedures detailed in the AOAC guidelines, 2010. The Moisture analysis was carried out using an automated moisture analyzer (ANDMX-50, Japan). For determining nitrogen content, the Kjeldahl method was employed, involving digestion and distillation with Kjeldahl Kel Plus equipment (KES06LR, Pelican, Chennai, India). Fat content was assessed through ether extraction, utilizing Socs Plus equipment (SCS08RTS, Pelican, Chennai, India). The analysis of crude fiber, both acid and alkali-resistant, as well as dietary fiber components, was performed enzymatically using Fibra Plus (FES08A DLS TS, Pelican, Chennai, India).

Ash content was estimated using a muffle furnace (KHERA Instruments, India). Total carbohydrate content was calculated by the method of difference. The analysis of dietary fiber content involved the application of the soxhlet apparatus to extract the water-soluble components from the sample. The resulting suspension underwent filtration, allowing for the collection of the insoluble residue, which was subsequently rinsed and dried to obtain the insoluble dietary fiber (IDF). In parallel, the retained filtrate underwent specific treatment to precipitate and isolate the soluble dietary fiber (SDF). This process involved acidification followed by the addition of ethanol, leading to the precipitation of polysaccharides. After filtration, washing, and drying, the soluble dietary fiber fraction was obtained. Both fiber fractions were processed and adjusted for ash and co-precipitated protein, following the method explained earlier by Rani *et al*. (2022).

In addition, the quantification of total calcium, iron, and zinc content was executed in accordance with the techniques elucidated by Lindsey and Norwell (1969), earlier explained by Jyoti *et al*. (2022). Furthermore, the examination of antioxidant properties, including DPPH radical scavenging activity, total phenolic content as described by Singleton *et al.* (1999), total flavonoids content based on the method by Zhishen *et al.* (1999), and ferric reducing antioxidant power in accordance with the protocols of Benzie and Strain (1996) and Tadhani *et al*. (2009) earlier explained by Verma *et al*. (2022), was carried out.

2.3 Intervention of *A. racemosus* root powder

Sixty postpartum women of similar socio-economic status with similar dietary pattern who have not smoked or had any type of intoxication during pregnancy, age 20-40 years, apparently healthy, free from chronic illness and not taking chronic medication were randomly selected for the study. Written consent was obtained from the subject for their voluntary participation in study. Selected women were assigned to two groups, *i.e*., control (n=30) and experimental (n=30) group. Experimental group was served with *A. racemosus* root powder (10 g/day) for 90 days. The mean age, height and weight of lactating women assigned to control group were 31.2 years, 155.93 cm and 62.10 kg, respectively whereas the mean age, height and weight of lactating women assigned to *A. racemosus* group were 31.5 years, 156.57 cm and 61.90 kg, respectively. To observe the effect of serving 10 g ARP among lactating women, serum prolactin hormone level was measured. Two ml blood sample was collected at 0-day and 91-day by the trained technician at hospital and analysed for prolactin hormone. The quantitative determination of prolactin hormone concentration (ng/ml) in human serum of blood sample was done by Micro plate Immunoenzymometric Assay (ELISA) technique at Vishnu Devi Janana Hospital, Hisar.

3. Results

3.1 Proximate and dietary fibre composition of *A. racemosus* root powder

The proximate composition of *A. racemosus* root powder has been outlined in Table 1. The moisture content of the *A. racemosus* root powder, based on fresh weight, was found to be 86.95 per cent. The analysis of *A. racemosus* root powder demonstrated a presence of 2.89 % crude protein content (Table 1). This finding highlights the moderate protein content within the root powder, emphasizing its nutritional value.

Table 1: Proximate composition of *A. racemosus* root powder (g/100 g)

Parameter	*A. racemosus* root powder
Moisture*	86.95 ± 1.97
Crude protein	2.89 ± 2.11
Crude fibre	10.59 ± 1.88
Crude fat	0.74 ± 0.98
Ash	6.55 ± 2.17
Total carbohydrate	11.28 ± 0.72
Soluble dietary fibre	5.88 ± 2.36
Insoluble dietary fibre	10.68 ± 3.17
Total dietary fibre	16.56 ± 2.99

Values are average of triplicate of observations (Mean ± SE).
*Moisture was analysed on fresh weight basis.

The nutritional evaluation of the *A. racemosus* root powder revealed a significant presence of crude fiber, with the crude fiber and ash content being measured at 10.59 and 6.55 per cent, respectively. The examination of the *A. racemosus* root powder indicated the presence of 0.74 % crude fat content and 11.28 % total carbohydrate content (Table 1). Understanding the fat and carbohydrate content in *A. racemosus* root powder is important for assessing its dietary significance and potential health benefits when incorporated into various food products or as a supplement.

The nutritional analysis of *A. racemosus* root powder highlighted its substantial dietary fibre content, with the total dietary fibre recorded at 16.56 %. Within this, the soluble dietary fibre constituted 5.88 % of the total dietary fibre, while the insoluble dietary fibre accounted for 10.68 % (Table 1). This significant presence of dietary fibre indicates the potential of *A. racemosus* root powder to contribute to gastrointestinal health, promoting regularity and overall intestinal function. The balance between soluble and insoluble dietary fibre is known to play a crucial role in maintaining digestive health, and the observed values emphasize the potential of *A. racemosus* as a beneficial dietary component.

3.2 Mineral profile of *A. racemosus* root powder

The thorough examination of the mineral composition of *A. racemosus* root powder, as outlined in Table 2, highlights the abundance of crucial minerals, including calcium, iron, and zinc. These findings underscore the resilience of these minerals during the processing of *A. racemosus* root powder, likely owing to their chemical associations within the plant material. Specifically, the analysis identified 178.48 mg of calcium, 24.14 mg of iron, and 2.11 mg of zinc in the *A. racemosus* root powder, calculated on a dry weight basis.

Table 2: Total mineral content of *A. racemosus* root powder (mg/100 g)

Parameter	*A. racemosus* root powder
Calcium	178.48 ± 3.17
Iron	24.14 ± 2.47
Zinc	2.11 ± 2.88

Values are average of triplicate of observations (Mean ± SE).

These results provide valuable insights into the potential nutritional benefits associated with the consumption of *A. racemosus* root powder, emphasizing its role as a natural source of essential minerals important for various physiological functions and overall well-being.

3.3 Antioxidants profile of *A. racemosus* root powder

Certainly, it appears that the antioxidant activity was harnessed to evaluate the presence of free radicals in the *A. racemosus* root powder, as demonstrated in Table 3. The recorded antioxidant content, including phenolic content, total flavonoid content, DPPH radical activity, and ferric reducing antioxidant power (FRAP) in the dried *A. racemosus* root powder, was noted as 5.22 %, 1.95 %, 70.30 %, and 1.98 %, respectively. Free radicals are formed in our body as a result of metabolic activities and ageing which needs to be neutralized by antioxidants to promote healthy long life.

Table 3: Antioxidants profile of *A. racemosus* root powder (%)

Parameter	*A. racemosus* root powder
Phenolic content (mg GAE/100 g)	5.22 ± 5.78
Total flavonoid content (mg RE/100 g)	1.95 ± 1.23
DPPH radical activity (mg TE/100 g)	70.30 ± 6.77
Ferric reducing antioxidant power (FRAP) (mg TE/100 g)	1.98 ± 4.58

Values are average of triplicate of observations (Mean ± SE)

3.4 *A. racemosus* root powder and prolactin level

Efficacy of *A. racemosus* root powder in increasing serum prolactin level has been presented in Figure 2. Results indicated that feeding of 10 g of ARP to postpartum women for 90 days has increased serum prolactin level from 151.81 to 296.07 ng/ml in comparison to postpartum women who served as control had experienced an increase in prolactin level from 148.97 to 232.62 ng/ml.

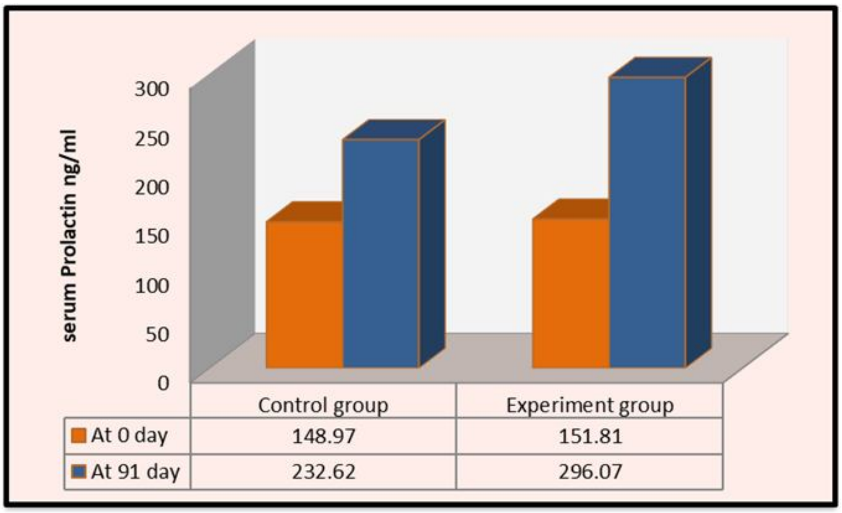

Figure 2: Effect of *A. racemosus* root powder on prolactin level of lactating women.

4. Discussion

The present study has thoroughly investigated the composition of root powder of *A. racemosus*, unveiling crucial information regarding its moisture content (86.95%), ash (6.55%), crude fiber (10.59%), crude protein (2.89%), crude fat (0.74%), and total carbohydrate (11.28%). Notably, these findings correspond with the results reported by Saini *et al.* (2016), confirming the significance of the present research. Moreover, the observed moisture content aligns with the conclusions drawn by Rani (2019), who emphasized the impact of blanching on moisture levels, a trend also recognized by Aathira *et al.* (2017). Contrarily, the study by Bruneton (1995) reported a significantly higher protein content of *A. racemosus* root powder (24.3%), deviating from the current investigation.

The current research findings on the protein content of dried *A. racemosus* root powder coincide with the results documented by Kumari and Gupta (2016), establishing a sense of consistency. Furthermore, the identified ash (4.5%) and crude fiber (14.8%) content align with the data presented by Saini *et al.* (2016), reflecting the robustness of the research. Particularly, the obtained results are in agreement with the observations made by Bruneton in 1995, signifying the reliability of the findings. The study conducted by Kumari and Gupta (2016) further supports the reported ash (3.55%) and fat (0.11%) content values in *A. racemosus* root powder, emphasizing the stability of the analysis. Studies by Nyman (1994) and McDougall (1996) have underscored the influence of diverse thermal treatments on the dietary fiber's characteristics, emphasizing the dynamic nature of these components.

The study conducted by Saini *et al.* (2016) consistently demonstrated the dietary fiber content in the root powder samples, with measurements showing 18.65 ± 0.42 g/100 g for insoluble fiber and 6.93 ± 0.15 g/100 g for soluble dietary fiber. The beneficial impact of dietary fiber on gastrointestinal tract mobility, including the maintenance of normal intestinal function and promotion of regularity, has been widely acknowledged. Additionally, the protective role of fiber in preventing colon diverticulosis has been well established. The current research findings are in concurrence with the results presented by Saini *et al.* (2016), indicating an iron content of 24.22 mg per 100 g of *A. racemosus* root powder. Earlier studies by Bruneton (1995) also underscored similar mineral compositions *in A. racemosus* root powder, highlighting the consistency of the observations.

The findings concerning the antioxidant activities closely correspond to previous research, notably Rani (2019), which highlighted a DPPH radical activity of 72.26% in blanched *A. racemosus* root powder. Saini *et al.* (2016) similarly documented the DPPH, FRAP, and total phenolic content in dried *A. racemosus* root powder as 62.7%, 2.6 %, and 4.62%, respectively. The antioxidative properties of *A. racemosus* root powder are attributed to its ferric ion-reducing properties, believed to be associated with the presence of reductones. These components function by disrupting the free radical chain through the donation of a hydrogen atom, thus exhibiting their anti-oxidative action (Shimada *et al.,* 1992). The reduction in phenolic content in tubers may be linked to leaching processes, as highlighted by Siddhuraju and Becker (2003). Additionally, it is plausible that phenolic compounds bind to other substances, forming insoluble complexes, as emphasized by Fernandez *et al.* (2003).

The study findings indicated that the mean prolactin levels at the onset of lactation (0-day) were 148.97 ng/ml in the control group and 151.81 ng/ml in the experimental group that increased in both the groups by the third month of the lactation period (91-day); however, this increase was found significantly higher in ARP group in comparison to control group. This substantial elevation in prolactin levels in the experiment group can be attributed to the administration of *A. racemosus* root powder as a supplement. Results of current research are corroborated with earlier findings of Gupta and Shaw (2011), they observed a 32.87 ± 6.48 per cent rise in prolactin level in experimental group after feeding 60 mg/kg of ARP for 30 days than placebo group. The precise mechanism by which ARP enhances serum prolactin levels remains uncertain. It has been hypothesized that its effects may be attributed to its phytoestrogenic properties, potentially involving the interaction of phytoestrogens with the estrogen receptor alpha (Er-α) (Penagos-Tabares *et al*., 2014; Bazzano *et al*., 2016).

5. Conclusion

It can be concluded that the in-depth nutritional analysis of *A. racemosus* root powder has highlighted its significant potential as a valuable natural dietary supplement and functional food ingredient. The root powder revealed noteworthy levels of essential components such as protein, dietary fiber, minerals, and antioxidants, indicating its potential health benefits. The high moisture content, substantial protein content, and considerable dietary fiber levels emphasize the nutritional significance of *A. racemosus* root powder. Additionally, the presence of crucial minerals like calcium, iron, and zinc, along with potent antioxidant activity, further underscore the potential therapeutic and health-promoting properties of this herbal ingredient. Intake of ARP as such or in the form of value-added food products can be highly beneficial for lactating mothers in improving milk production as it imposes significant effect on prolactin level. The findings suggest that *A. racemosus* root powder can serve as a promising natural alternative in various food and pharmaceutical applications, presenting a holistic approach to enhancing overall well-being and health. Further research and exploration into the bioactive compounds and potential health effects of *A. racemosus* root powder are warranted to fully unlock its therapeutic potential and promote its integration into contemporary healthcare practices.

Conflict of interest

The author declares no conflicts of interest relevant to this article.

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