

HARNESSING THE NUTRITIONAL, PHYTOCHEMICAL AND PHARMACEUTICAL PROPERTIES OF *Drynaria quercifolia* RHIZOME POWDER INCORPORATED DOUGHNUTS

Surabi C.S¹, Arivuchudar.R^{*2}

¹ Dietician, PSG Hospital, Coimbatore

² Assistant Professor, Department of Nutrition and Dietetics, Periyar University, Salem

Corresponding author Email id: achudar24@gmail.com

ABSTRACT

Drug discovery from plants have significantly contributed to treatment of many ailments. The oak leaf fern, namely Drynaria quercifolia, from the Polypodiaceae family of Pteridophytas profusely seen in India's evergreen forests. It is mostly grown as a medicinal plant and is native to hot counties in Asia, Africa, and Australia. Also referred to as "Ashwakatri" in the Ayurvedic medical system Drynaria quercifolia is used by a number of tribal people to cure conditions like chronic jaundice, dyspepsia, fever, cough, and chest infections. The rhizome is mashed into a paste and administered topically to cure long-term sleeping disorders, headaches, and skin diseases. In many regions, this paste is combined with coconut oil and used topically. Doughnts or Donuts are snacks relished by people of all age groups. Typically made of refined flour dough, doughnuts are deep-fried and come in ring or hole-shaped shapes. They are also frequently filled. However, the doughnut becomes a healthier snack when it is baked instead of fried. By using Drynaria quercifolia powdered rhizome as the foundation for doughnut flour, its nutritional makeup, medicinal properties and health advantages will be improved. 2.5g, 5g, and 7.5g of Drynaria quercifolia powdered rhizome were utilized in each donut. The sensory attribute of each variation of doughnut was determined. The proximate composition, micronutrients and phytochemicals present in the doughnuts with highest sensory score was identified.

KEYWORDS *Drynaria quercifolia, Medicinal Properties, Nutrients, Phytochemicals*

INTRODUCTION

Medicinal plants are those with one or more of its organs containing properties that can be used for therapeutic purpose or which used as precursor for the synthesis of various drugs. Originating from tropical regions of Africa, Asia, and Australia, its primary purpose of cultivation of *Drynaria quercifolia*, is for medicinal purposes. In many nations, particularly in Asia, it is essential to ethnomedicine. The plant has a modest height range of 60-100 cm and a thick, thickly scaly brown rhizome that creeps with time. Dimorphic sterile and fertile fronds are the two variations of fronds. Unlike the fertile fronds, the sterile types are substantially shorter and primarily brown in colour. The colour of fertile fronds is green. The long *Drynaria quercifolia* rhizomes grow horizontally under the ground surface and helps to stabilize the soil. The branched root systems of ferns aid to add moisture to the soil, thereby preventing erosion. *Drynaria quercifolia* typically thrives in damp, low-lying, fertile areas. For centuries, the application of plants in curing a diverse range of illnesses have been explored. An astounding number of contemporary medications have also been made using these plants. In Chinese medicine, *Drynaria quercifolia* had been used to treat low back pain in women. *Drynaria quercifolia* rhizome soup is a popular drink to relieve rheumatic sighs. *Drynaria quercifolia* rhizome paste has found use in the treatment of skin diseases, fever, headaches, chronic jaundice, cholera, typhoid, and diarrhoea (Sutha et al., 2010). The leaves and rhizome of *D. quercifolia* are used for the treatment of intestinal worms, rheumatism and sleeping disorder by the tribes of Tripura, Kalakad and Phulpur. The rhizome extract that was used showed the presence of antioxidants and possessed anti-diabetic activity. The rhizome of the fern *Drynaria quercifolia* is one of a drug constituents used in the treatment of cancer. "Ashwakatri" in the Ayurvedic medical system is a remedy for dyspepsia, cough, and chest infections⁷. The plant rhizome used against typhoid fever and also used as anti-fertility agent and also used to lowers body temperature (antipyretic agent) (Samyudurai et al., 2012). Peeled Rhizome with sugar is recommended to treat urinary disorders and spermatorrhoea.

The phytochemical profile and anti-inflammatory properties of *Drynaria quercifolia* rhizome (DQ) ethanolic extract are due to the flavonoids, triterpenes, alkaloids, glycosides, saponins and amino acids present. Rats' paw oedema and granuloma development generated by carrageenan were significantly inhibited by oral administration of *Drynaria quercifolia*, with the effects being nearly identical to those of indomethacin. have also documented the anti-oedematous and anti-proliferative properties of the ethanolic extract of *Drynaria quercifolia* fertile fronds using conventional methods (Anuja et al., 2010).

Though many studies have proved the therapeutic properties of *Drynaria quercifolia* rhizome, people are not willing to consume the same in regular diet. Hence, the utilisation of *Drynaria quercifolia*

rhizome in fried dough confectionery or dessert dish called a doughnut or donut has been trialled in this study. Doughnut is a common snack in many nations, and can be cooked at home or purchased from bakeries, supermarkets, food carts, and approved specialized stores in a variety of formats. Food historians speculate that the doughnut's ancestors created it out of leftover dough fragments that had to be consumed. Fruit or confections were frequently used as fillings in the early doughnuts. The doughnut took shape when the original cooks shaped it into different shapes, such as knots (Suvendu Bhattachary, 2022).

The objectives of the present study are to develop *Drynaria quercifolia* rhizome powder and formulate different variations of value-added doughnut by incorporating *Drynaria quercifolia* rhizome powder, to determine the physical properties, to evaluate the acceptability of the developed products by organoleptic evaluation and to analyse the nutritional value and phytochemicals in the sensorily accepted variation of doughnut.

NEED AND SCOPE OF THE STUDY

The study aims to develop a nutritious doughnut to maintain optimal nutritional status and to prevent non-communicable diseases. These doughnuts which prepared by combining rarely used *Drynaria quercifolia* rhizome powder, wheat flour, brown sugar that provide complex carbohydrates, protein, fiber, micronutrients and nutraceuticals. The doughnuts have been formulated as it is most popularly sought snack and in this study they are prepared by baking rather than frying, and incorporation of *Drynaria* makes it a healthier snack.

The methodology adopted to attain the objectives of the study is as follows:

METHODOLOGY

The ingredients required for the development of value-added doughnuts namely wheat flour, *Drynaria quercifolia* rhizome, brown sugar, and yeast were procured from Yercaud.

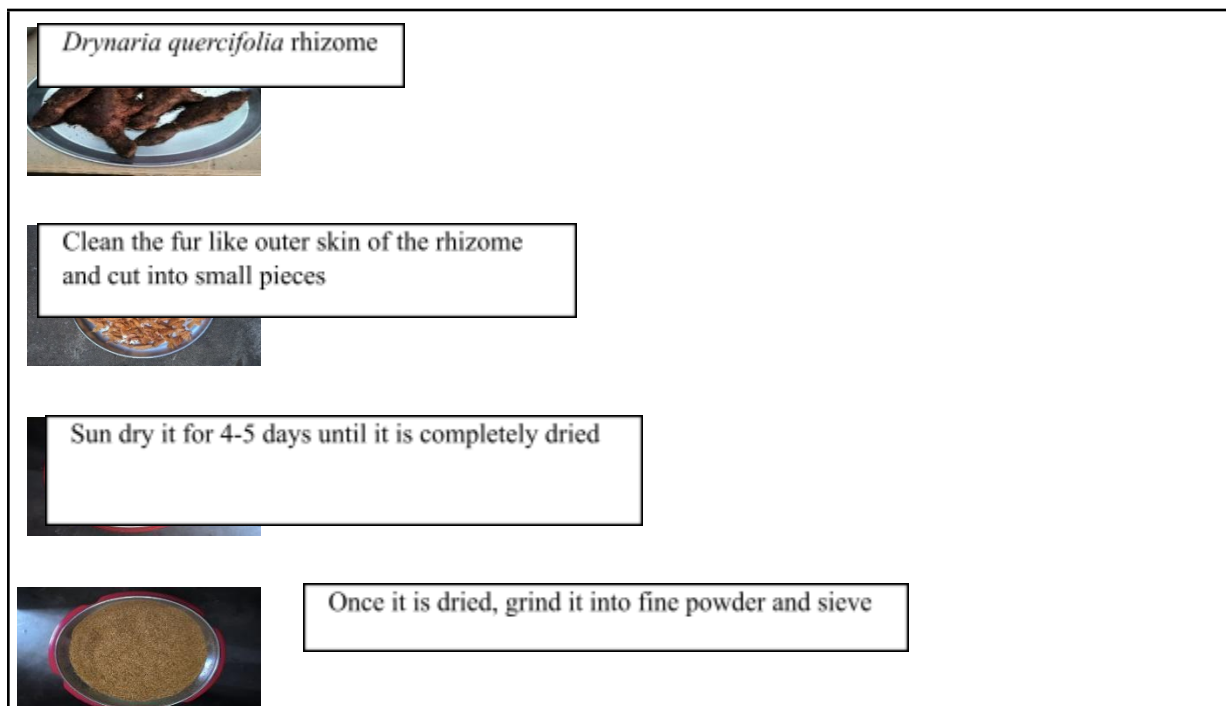


FIGURE 1- FORMULATION OF *Drynaria quercifolia* RHIZOME POWDER INCORPORATED DOUGHNUT

The rhizome was washed thoroughly until the soil is cleared. The furry outer skin was removed using knife. Then the rhizome was cut into small pieces. Again, it was washed with cold water and kept under sunlight to dry. After five days, once completely dried, it was transferred into a mixer and grinded into powder and sieved to reduce the residues. The amount of ingredients incorporated for formulating control doughnut and different variations of *Drynaria quercifolia* rhizome powder incorporated doughnut is shown in Table 1.

TABLE-1 INGREDIENTS FOR THE FORMULATION OF *Drynaria quercifolia* RHIZOME POWDER INCORPORATED DOUGHNUT

INGREDIENTS	LEVEL OF INCORPORATION			
	CONTRO L	DVI	DVII	DVIII
Wheat flour(g)	100	97.5	95	92.5
<i>Drynaria quercifolia</i> rhizome powder(g)	-	2.5	5	7.5
Brown sugar(g)	20	20	20	20
Yeast(g)	3	3	3	3
Butter(g)	5	5	5	5

DVI- Doughnut Variation -I, DVII- Doughnut Variation -II, DVIII- Doughnut Variation -III. The control doughnut was prepared only with 100% wheat flour, while the rest of the ingredients were same as for other variations. DVI- Doughnut Variation -I was formulated with 2.5 gm of *Drynaria quercifolia* rhizome powder and 97.5 gm wheat flour, while DVII- Doughnut Variation -II was formulated with 5gm of *Drynaria quercifolia* rhizome powder and 95 gm wheat flour, and DVIII- Doughnut Variation -III was formulated with 7.5gm of *Drynaria quercifolia* rhizome powder and 92.5gm wheat flour. The other ingredients used were 20gms of brown sugar, 3gms of yeast and 5gms of butter for each variation and control doughnut.

The dough for control and each of the variations of doughnut were prepared separately and set aside for 10 minutes. The dough was rolled, cut into desired shape and baked at 140°C for 25 minutes. The doughnuts are ready for evaluation.

ACCEPTABILITY OF THE DOUGHNUTS BY ORGANOLEPTIC EVALUATION: The control and the developed doughnuts (DV I, DV II and DV III) were subjected to organoleptic evaluation. The panelist evaluated the doughnuts for sensory characteristics using 9-point hedonic scale.

ANALYSIS OF NUTRIENTS AND PHYTOCHEMICALS IN THE CONTROL AND THE ACCEPTED VARIATION OF *Drynaria quercifolia* RHIZOME POWDER INCORPORATED DOUGHNUTS: The highly rated variation of *Drynaria quercifolia* powder incorporated doughnuts was assessed for nutrients and phytochemicals as per standard laboratory procedures (AOAC, 2023).

RESULTS AND DISCUSSION

The control doughnut and different variations of formulated *Drynaria quercifolia* rhizome value added doughnuts were subjected to sensory evaluation and nutritional and phytochemical screening.

SENSORY EVALUATION OF CONTROL AND DEVELOPED VARIATIONS OF *Drynaria quercifolia* RHIZOME POWDER INCORPORATED DOUGHNUT

The developed variations of *Drynaria quercifolia* rhizome powder incorporated doughnut were organoleptically evaluated using parameters such as appearance, taste, texture, flavor and colour. Nine-point hedonic scale method was adopted to estimate the acceptance of the developed products.

TABLE -2 STATISTICAL ANALYSIS OF MEAN SENSORY VALUES OF CONTROL AND DEVELOPED DOUGHNUTS

VARIATIONS	APPEARANCE	COLOUR	TASTE	TEXTURE	FLAVOR	OVERALL ACCEPTABILITY
Control	7.70±0.80 ^c	6.45±0.51 ^a	7.80±0.69 ^b	7.65±0.93 ^b	7.50±0.94 ^b	7.80±0.83 ^c
DV I	7.85±0.67 ^c	7.30±0.86 ^b	8.10±0.64 ^b	8.15±0.74 ^c	8.05±0.69 ^c	8.35±0.59 ^d
DV II	6.95±0.69 ^b	7.95±0.69 ^c	7.10±0.69 ^a	6.25±0.44 ^a	7.15±0.67 ^a	7.15±0.74 ^b
DV III	6.35±0.49 ^a	8.00±0.46 ^c	7.00±0.56 ^a	6.55±0.76 ^a	6.70±0.66 ^a	6.55±0.69 ^a
Significance	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*

*Significance at 5% level. Samples with different superscripts within a column are significantly different from one another at ($p \leq 0.05$).

Results of Duncan multiple range tests for determining the sensory evaluation (Appearance, colour, taste, texture, flavor and overall acceptability) of the doughnut prepared with 2.5 gm, 5 gm, and 7.5 gm variations of *Drynaria quercifolia* rhizome powder are presented in the above table and it showed that there was a significant difference ($p \leq 0.05$) between the control and all the variations of the formulated doughnut.

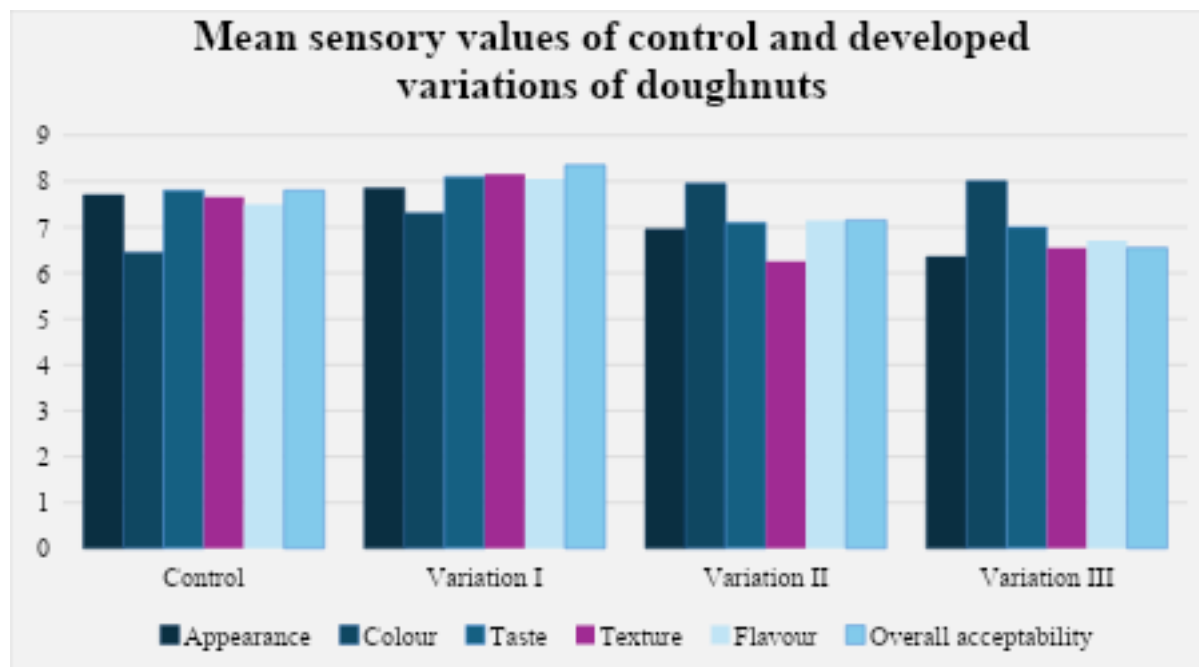


FIGURE -1 MEAN ORGANOLEPTIC VALUES OF THE DEVELOPED VARIATIONS OF DOUGHNUTS

The above graphical depiction comprehends the mean organoleptic values of control doughnut and developed doughnut, thus out of 3 variations, Variation I (DV I) obtained high mean values as 7.8 for appearance when compared to other attributes. The taste score of DV I was 8.10 which was higher than control and other variations, the texture score of DV I was 8.15 which was greater than developed variations, the mean score of colour of DV I was 8 which was higher than control and other variations, the flavor of the DV I scored 8.05 which was greater than control and the overall acceptability of DV I was 8.35 which was found to be the highest of all other developed variations. Based on the sensory evaluation of the developed doughnuts, 2.5gm *Drynaria quercifolia* rhizome powder incorporated doughnut i.e., DV I was more acceptable. Hence further analysis of nutrients and phytochemicals were done for DV I.

NUTRITIONAL ANALYSIS OF *Drynaria quercifolia* INCORPORATED DOUGHNUT

The nutritive value of accepted variations of doughnut was assessed. The nutrient assessed includes energy, carbohydrates, protein, fat, dietary fiber, iron, calcium, phosphorus, magnesium and phytochemicals.

**TABLE -3 NUTRITIONAL COMPOSITION OF *Drynaria quercifolia* RHIZOME POWDER
INCORPORATED DOUGHNUT**

S. NO	PARAMETERS	CONTROL	ACCEPTED VARIATION (DV-I)	DIFFERENCE
1	Energy (Kcal/100g)	473	340	-133
2	Protein(g/100g)	7.9	10.5	+2.6
3	Fat(g/100g)	4.97	8.7	+3.73
4	Carbohydrate(g/100g)	39.3	54.8	+15.5
5	Fiber(g/100g)	0.7	3.1	+2.4
6	Total sugar(g/100g)	11.7	10	-1.7
7	Iron(mg/100g)	2.73	6.2	+3.47
8	Calcium(mg/100g)	38.6	75	+36.4
9	Magnesium(mg/100g)	9.4	38	+28.6
10	Phosphorus(mg/100g)	125.67	196	+70.33

The above table shows that the energy obtained from the accepted variation of doughnuts was found to be 340 Kcal/100g. The protein obtained from the accepted variation of doughnuts was found to be 10.5g/100g. From the accepted variation of doughnuts, the fat content was found to be 8.7g/100g, while incorporating Cardaba banana flour as a functional ingredient for wheat flour in the production of , the dietary fiber content of the accepted variation of the doughnuts was found to be 3.1 g/100g and the ash content of the developed doughnuts was 1.6g/100g. 38mg and 196mg of magnesium and phosphorus were respectively present. Iron an essential element for diverse metabolic processes, including oxygen transport, deoxyribonucleic acid synthesis, and electron transport was found to be 6.2mg in the developed doughnut. The calcium content was 75mg in the 100 gms of accepted variation of doughnut.

TABLE -4 PHYTOCHEMICALS IN ACCEPTED VARIATION OF DOUGHNUT

S. NO	PHYTOCHEMICAL S	PRESENT/ ABSENT
1	Friedelin	Present
2	Epi Friedelin	Present
3	Beta-amyrin	Present
4	Saponin	Present
5	Tannin	Present
6	Alkaloids	Present

Phytochemicals analysis of *Drynaria quercifolia* rhizome powder incorporated doughnuts showed the presence of saponin, tannin, alkaloids, Friedelin, Epi Friedelin and β -amyrin. Studies indicate that the saponins lower blood glucose and lipid levels, and cancer risks. A high saponin diet inhibits dental caries and platelet aggregation, significantly used to treat hypercalciuria, and proves as an antidote against acute lead poisoning. 200mg of daily saponin intake is the normal range (Selvi et al., 2016). Friedelin and epi-friedelin are alkaloids isolated mostly from various mosses and lichen. They are anti-inflammatory, antioxidant, anti-cancerous, and antimicrobial in action (Kaur and Aroraa, 2015). Friedelin also important in farming due to its anti-insect effect (Anshuman,2023). β -amyrin found in many medicinal plants exhibited anti-Parkinsonian effects, anti-oxidant activity and reduced intracellular oxygen species. β -amyrin reduced cell damage persuaded by 6-hydroxydopamine and reduced aggregation of α -synuclein (Waqas Alam, 2023).

CONCLUSION

Drynaria quercifolia rhizome is not familiar among people but its nutritional value and health benefits are substantial. Different groups of people employ *Drynaria quercifolia* in their medicinal systems to treat different types of health issues. In conventional Indian Ayurvedic medicine, it is significant. Beyond the health advantages associated with macronutrients and micronutrients, phytochemicals are naturally occurring, physiologically active chemical compounds found in plants. The macro and micronutrients and phytonutrients in the rhizome of *Drynaria quercifolia* are beneficial for a number of illnesses. Quickened wound healing, expectorant and cough relief, relief from abdominal-renal colic pain, intermittent fever, and treatment of joint pain, osteoporosis, arthritis, and typhoid fever are just a few to mention. This study has proved that the The incorporation of the rhizome in favourite foods is possible. The rhizome must be made available widely across the stores and should find its use in everyday cooking to enhance the quality living and health status of the individuals.

CONFLICT OF INTEREST

The authors have no conflicts of interest regarding this investigation.

ACKNOWLEDGMENT

The authors would like to thank the authors of the literary sources cited in this article.

REFERENCES

1. Anshuman K.P. 2023. Phytochemicals: An immune booster against the pathogens. In: Pati S., Sarkar T., Lahiri D., editors. Recent Frontiers of Phytochemicals. Elsevier; Amsterdam, The Netherlands: 2(3), 501–509.
2. Anuja, G. I., Latha, P. G., Suja, S. R., Shyamal, S., Shine, V. J., Sini, S., and Rajasekharan, S. 2010. Anti-inflammatory and analgesic properties of *Drynaria quercifolia* (L.) Journal of ethnopharmacology, 132(2), 456-460.
3. Kaur R., and Arora S. 2015. Alkaloids—Important Therapeutic Secondary Metabolites of Plant Origin. J. Crit. Rev. 2:1–8
4. Official Methods of Analysis of AOAC INTERNATIONAL, 22nd Edition. Oxford University Press. <https://doi.org/10.1093/9780197610145.001.0001>
5. Samyadurai P, Thangapandian V., Aravinthan V, 2012. Wild habitats of Kolli Hills being staple food of inhabitant tribes of eastern Ghats, Tamil Nadu, India. Indian J Nat Prod Res; 3:432-437.
6. Selvi, B. Padma, G. Prasanna, and Anuradha. R. 2016. Physicochemical and phytochemical analysis of the rhizome of *Drynaria quercifolia* L. *Int J Phytopharm* . 7,18-22.
7. Sutha, S., Mohan, V.R., Kumaresan, S., Murugan, C., Athiperumalsamy T. 2010. Ethnomedicinal plants used by the tribals of Kalakad-Mundanthurai Tiger Reserve (KMTR), Western Ghats, Tamil Nadu for the treatment of rheumatism. Indian J Tradit Knowledge, 9:502-509.
8. Suvendu Bhattacharya, 2022 Snack Foods: Processing and Technology. Academic Press.
9. Waqas Alam, Imad Ahmed, Mubarika Ali, Faizullah Khan, and Haroon Khan. 2023. Neuroprotective effect of terpenoids. In Phytonutrients and Neurological Disorders, Academic Press, 227-244.