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Formulation, Nutritional Profile and Sensory Acceptability of Cookies and Bread Fortified with Medicinal Plant Extracts

S.Kamalasundari
Assoc. Prof. (FSN), Dryland Agricultural Research Station,
Tamil Nadu Agricultural University, Chettinadu-630 102, Tamil Nadu
Corresponding author: kamalasundari.s@tnau.ac.in

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Abstract

Herbs carry unique anti-oxidants, essential oils, vitamins, phyto-sterols and many other plants derived nutrient substances, which help equip our body to fight against germs, toxins and to boost immunity level. Among them, Indian borage (Plectranthus amboinicus) helps in curing ulcers, menstrual, post-natal disorders and boosts appetite. Lemon grass (Cymbopogon citrates) alleviates gastrointestinal problems, stomach aches, diarrhea, bloating, bowel spasms, vomiting, fever, flu and headaches. This study explored the possibility of incorporating dry leaf powders of Indian borage and Lemon Grass @ 5% and 10% in cookie and bread recipes. The acceptability of the products evaluated by 12 panel members reported that at 10% incorporation level had higher overall acceptability, taste, texture and flavor. The results demonstrated high protein and low moisture in cookies and better texture of bread. In conclusion herbs up to 10% can be incorporated to improve the consumption of bioactive components and nutrition without affecting the product sensory quality and shelf-life when stored in room and refrigerated conditions.

Key words: Cookies, Bread, Indian borage, Lemon grass, formulation

INTRODUCTION

Medicinal plants are very important to human beings in preserving health. Nature has been a source of medicinal agents for thousands of years. There is a growing interest in the pharmacological evaluation of various plants used in Indian traditional systems of medicine. Herbal medicines are one type of dietary supplement. An herb can be any form of a plant or plant product, including leaves, stems, flowers, roots and seeds. They are sold as tablets, capsules, powders, teas, extracts and fresh or dried plants. When used as raw or as extracts, the resulting products contain dozens of chemicals, including fatty acids, sterols, alkaloids, flavonoids, glycosides, saponins and others. People use herbal medicines to maintain and sustain or improve their health. Many people believe that products labelled "natural" are always safe and good for them.

By 2026, India's bakery industry is estimated to be worth ₹1.35–1.45 trillion, making it one of the largest segments within the processed food sector. The industry includes packaged bread, biscuits, cakes, pastries, rusks, buns, cookies, and a growing range of savoury baked snacks. The cookie industry has been projected to grow at a CAGR of 5.52% during 2026-34. Functional food is the emerging market in the bakery industry. Other possible developments are fortification and the addition of herbs, which are thought to increase the absorption of nutrients (Dhankar, 2013). Increasing awareness regarding health and nutrition leads to the development of bakery products as functional foods and thereby it becomes bright for further development of bakery industries India is rich with a flora of indigenous medicinal plants that have been used for centuries in traditional Indian medicine to treat human maladies (Lipi Das et al., 2012, Karthikeyan et al., 2018).

Cookie and Bread recipes are the most popular bakery items consumed nearly by all sections of the society. Bakery products are used as a vehicle for incorporation of different nutritionally rich ingredients. Already pepper (1%) is being added to increase the absorption of bioactive components (Abu-Seif et al., 2009). Reports of therapeutic effects of Lemon grass decoction on lab animals have already been documented (Carlin et al., 1986).

Herbals are considered as easily available sources to boost the immune system. The herbs selected for this study are Indian borage (*Plectranthus amboinicus*) and Lemongrass leaves-(*Cymbopogon citrates*). Both these herbs contain polyphenols such as tannin, flavonoids and anthocyanins.

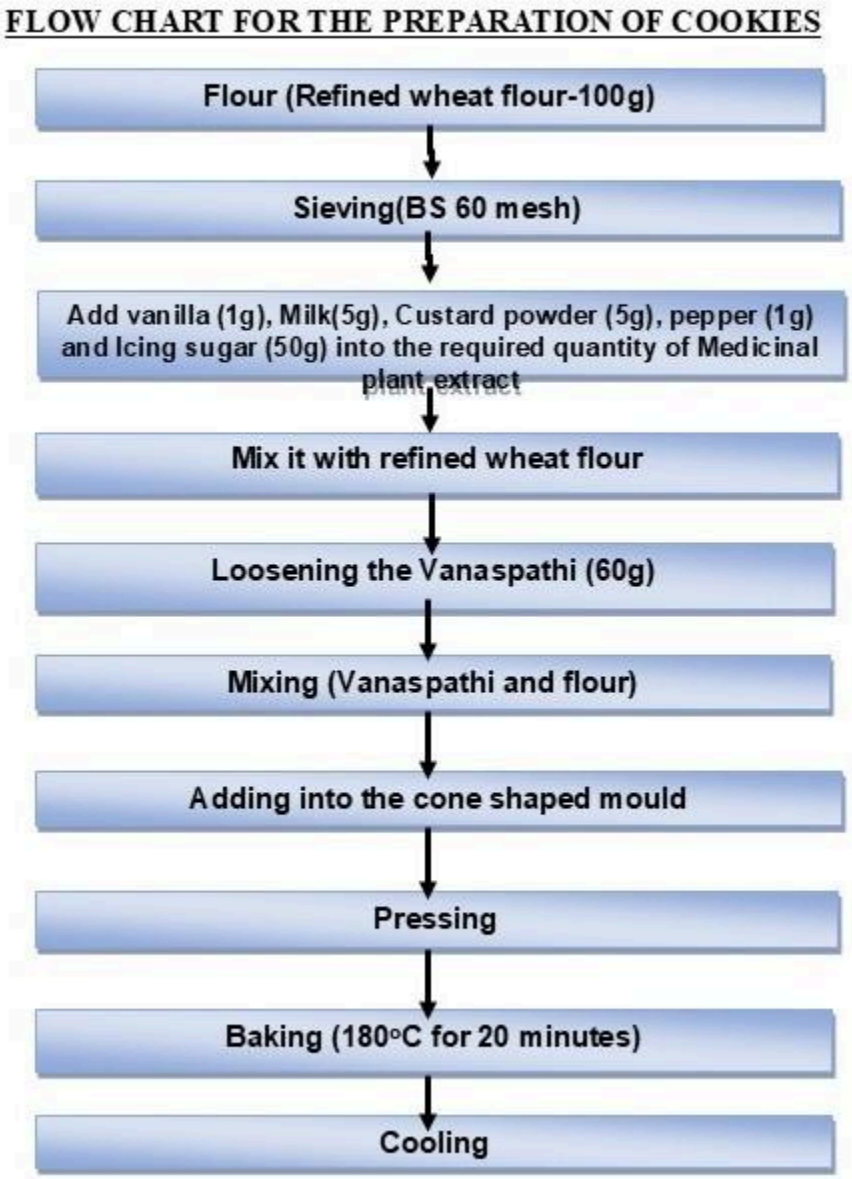
Fresh leaves of Indian borage and Lemon grass procured from a local market were washed with water, shade dried and powdered in a domestic mixer grinder and stored in an airtight container. Medicinal plant decoction was made by adding required quantities of powder (5% and 10%) to boiling water and filtered using muslin cloth. These decoctions were incorporated in bread dough and cookies at different levels by weight.

MATERIALS AND METHODS

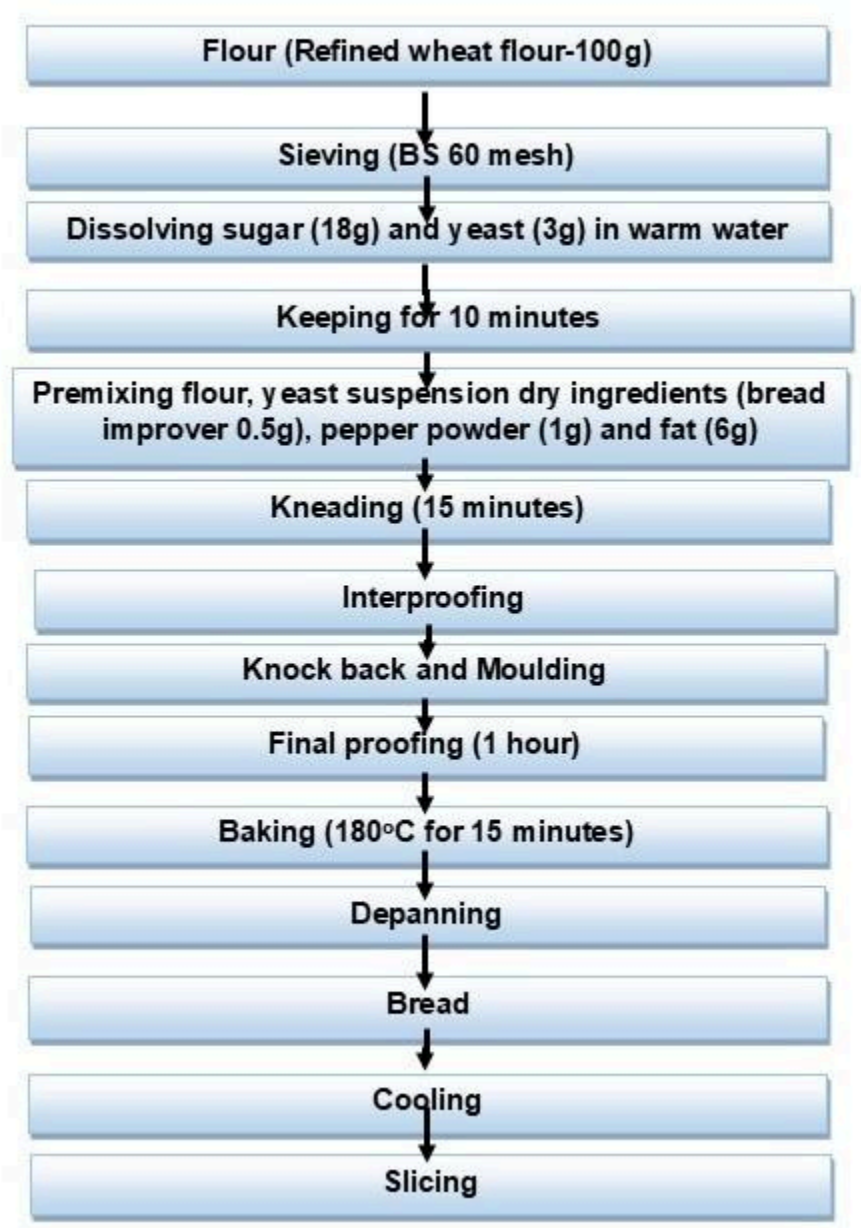
Formulation and preparation of cookies and bread: Cookies were prepared by incorporating Indian borage and Lemongrass leaf extracts at 5 and 10% levels. The ingredients used in the preparation of control / standard cookies were refined wheat flour (100g), icing sugar (50g), pepper powder (1g), Vanaspathi (60g), vanilla, milk and custard powder (1g, 5g and 5g respectively), salt (1g), water (40ml). The ingredients used in the preparation of control/ standard

bread were refined wheat flour (100g), sugar (18g), yeast (3g), salt (1.5g), bread improver (0.5g), pepper (1g), Dalda (6g). In standard breads, instead of water, medicinal plant extracts were added at required quantities. In bread preparation, all dry ingredients were mixed by using yeast suspension followed by fat, mixed well and kneaded for 15 minutes. The dough was covered with a wet cloth and kept for one hour, knocked back and transferred into the greased bread mould as final proving for one hour. The dough was baked at 180°C for 15 minutes, cooled and packed. In standard cookies instead of water medicinal plant extracts (5%, 10%) were added. The dough was added into a cone shaped mould and it was pressed to get desired shaped cookies, baked in an oven at 180°C for 20 minutes.

Sensory evaluation of the developed product: The organoleptic qualities of the developed product were assessed by the 12 taste panel immediately after the preparation of the product. In this test, 9 point Hedonic scale was used to score the baked products according to their concentration.


FLOW CHART FOR THE PREPARATION OF COOKIES
Flour (Refined wheat flour-100g)
Sieving(BS 60 mesh)
Add vanilla (1g), Milk(5g), Custard powder (5g), pepper (1g) and Icing sugar (50g) into the required quantity of Medicinal plant extract
Mix it with refined wheat flour
Loosening the Vanaspathi (60g)
Mixing (Vanaspathi and flour)
Adding into the cone shaped mould
Pressing
Baking (180°C for 20 minutes)
Cooling

FLOW CHART FOR THE PREPARATION OF BREAD



RESULTS AND DISCUSSION

In this study T1 served as control (cookie) and T2 ad control (bread) in which only refined wheat flour was used while in other samples 5%, 10% Lemon grass cookies named as T1H1, T1H2 and 5%, 10% Indian borage cookies as T2H1, T2H2. Similarly, 5%, 10% Lemon grass bread named T3H1, T3H2 and 5%, 10% Indian borage bread named T4H1, T4H2.

The proximate composition of the raw materials for cookies and bread are presented in Table 1.

Table 1. Nutritional profile Of Raw Ingredients

Raw materials	Moisture (%)	Total ash (%)	Titrable acidity (g)	Water soluble ash (g)	Acid insoluble ash (g)
Lemon grass leaf	6.4	4.32	0.068	40.5	25.0
Indian borage	8.4	5.12	0.077	32.3	19.0
Refined wheat flour	5.47	3.50	-	-	0.90
Milk powder	3.5	5.6	-	-	0.43

Meena Mehta (2013) Titrable acidity of Lemon grass and Indian borage powder were 0.068 and 0.077(g) respectively.

Nutritional profile of standardized products

The nutritive status of the cookies and bread were analyzed and tabulated in Table 2. The major parameters carbohydrate, protein, fat, fiber, iron, calcium and tannin were determined. The product which scored highest overall acceptability was subjected for further proximate analysis. In general, 10% level of incorporation received higher overall acceptability which was taken as a standardized product.

Table 2. Nutritional profile of standardized products

Standardized product	**Moisture (g)**	**Ash (g)**	**Carbohydrate (g)**	**Protein (g)**	**Fat (g)**	**Fibre (g)**	**Iron (mg)**	**Calcium (mg)**	**Tannin (mg)**
T1- (Control Cookies**)**	4.2	0.62	60.10	9.2	30	0.67	1.66	13.71	41.11
T1H2- (Lemon grass 10% cookies)	3.0	0.21	56.40	14.0	28	1.00	1.92	14.43	44.31
T2H2 -(Indian borage 10% cookies)	3.2	0.61	55.69	14.0	29	0.67	1.99	18.01	44.28

T2-(Control Bread**)**	40	1.7	86.05	9.4	4	0.55	1.57	17.04	52.32
T3H2 (Lemon grass 10% bread)	36	1.2	80.46	13.1	5	0.67	2.11	19.86	55.86
T4H2- (Indian borage 10% bread)	38	0.9	80.61	13.6	4	1.00	3.35	20.58	55.84

The legends for the treatments were; **T1** – Control cookies, **T1H2 -** Lemon grass cookies **T2H2 -** Indian borage cookies, **T2 –** Control Bread **T3H2 -** Lemon grass bread **T4H2 -** Indian borage bread

The moisture content of T1H2, T2H2, T3H2 and T4H2 was 3.0, 3.2, 36 and 38 respectively. In control cookies and bread the moisture content is 4.2 and 40(g) respectively. Moisture decreased by the addition of medicinal plant extracts (Lemon grass and Indian borage) in cookies and bread. Low moisture indicates the longer shelf life of the product. The ash content of T1H2, T2H2, T3H2 and T4H2 was 0.21, 0.61, 1.2 and 0.9 respectively. In control cookies and bread the ash content is 0.62 and 1.7(g) respectively. When compared to control cookies there is an increase in ash content by the addition of medicinal plant extracts (Lemon grass and Indian borage) in cookies and bread. The results are in line with reports of Pankaj Sharma et al. (2013) who reported that developed cookies by incorporating Guduchi (*Tinospora cordifolia*) leaf powder had 11.5% moisture, 0.5% ash, 9.8% dry gluten, 10.4% protein, 3.6% dietary fiber, 2.4 mg % iron and 22.6 mg % calcium.

In control cookies (T1) the assessed carbohydrate, protein, fat, fibre, iron and calcium content was 60.1g, 14.0g, 30g, 0.67g, 1.66mg and 13.71mg respectively. In Lemon grass cookies (T1H2), the carbohydrate, protein, fat, fiber, iron and calcium was 56.40g, 14.0g, 28g, 1.00g, 1.92mg and 14.43mg respectively. In Indian borage cookies (T2H2), the carbohydrate, protein, fat, fibre, iron and calcium was 55.69g, 14.0g, 29g, 0.67g, 1.99mg and 18.01mg respectively. It was observed that all chemical parameters increased in standardised Lemon grass and Indian borage cookies when compared to control. Among the standardised cookies Lemon grass cookie had the highest fibre (1.0g) content. Standardized Indian borage cookies had the highest iron (1.99mg) and calcium (18.01mg) content. Mittal et al*.,* (2020) in his study,

reported that incorporating *Tinospora cordifolia* between 1.5 to 4.5% in cookies increased water absorption, dough development time and mixing tolerance index and decreased dough stability. The addition also resulted in increased hardness and decreased dough cohesiveness and decreased spread ratio of cookies.

In control bread (T2) the carbohydrate, protein, fat, fibre, iron and calcium content were 86.05g, 9.4g, 4g, 0.55g, 1.57mg and 17.04mg respectively. In Lemon grass bread (T3H2) the carbohydrate, protein, fat, fibre, iron and calcium were 80.46g, 13.1g, 5g, 0.67g, 2.11mg and 19.86mg respectively. In Indian borage bread (T4H2) the carbohydrate, protein, fat, fibre, iron and calcium were 80.61g, 13.6g, 4g, 1.00g, 3.35mg and 20.58mg respectively. It was observed that all chemical parameters increased in standardised Lemon grass and Indian borage bread compared to control. The Lemon grass (10%) bread (T3H2) was found to be high in carbohydrate which is 80.46g. The Indian borage (10%) bread (T4H2) was found to be high in protein which is 13.6g and low in fat which is 4g. The Indian borage bread (T4H2) was found to be highly rich in iron which is 3.35mg and also highly rich in calcium which is 20.58mg.

The selected herbs contain alkaloid, flavonoid and tannin in nature. Tannin was once considered as "anti-nutrient" due to their metal chelating and enzyme inhibiting activities Babayi et al., (2004). But nowadays they are termed as nutraceuticals because of its non-toxic and may slow digestibility in humans, which is an advantage to type II diabetics. Tannin content of the control, Lemon grass (T1H2) and Indian borage cookies (T2H2) was 41.11, 45.17mg and 44.28mg respectively. Tannin content of the control, Lemon grass (T3H2) and Indian borage bread (T4H2) was 52.32 55.86mg and 55.84mg respectively. The Lemon grass bread (T3H2) was found to be high in tannin which is 55.86mg as already summarized by Shah et al (2011) who reported the medicinal value of lemongrass in improving human health.

Sensory Evaluation of Standardized Products

The properties including Colour, Appearance, Flavour, Taste, Texture and Overall acceptability were evaluated and judged for their quality. It was observed that T1H1, T1H2, T2H1, T2H2 had a score for colour as 8.4, 8.7, 8.2, and 8.9 respectively (Table 3). The colour of Lemon grass and Indian borage cookies scored well at 10% incorporation level (T1H2, T2H2) as 8.7 and 8.9 respectively.

Table 3. Sensory Characteristics of Medicinal Plant Extract Incorporated Cookies and Bread

Treatment	Incorporation level	SENSORY ATTRIBUTES					
		Colour	Appearance	Flavour	Taste	Texture	Overall acceptability
T0	-	8.0	8.1	7.2	7.0	8.0	8.0
T1H1	5%	8.4	8.5	7.9	7.5	8.2	8.3
T1H2	10%	8.7	8.6	8.6	8.5	8.2	8.8
T2H1	5%	8.2	8.5	8.0	8.3	8.2	8.4
T2H2	10%	8.9	8.9	8.3	8.6	8.3	8.9
T1	-	7.6	7.8	8.0	8.2	7.5	8.0
T3H1	5%	8.0	8.1	8.3	8.5	7.9	8.0
T3H2	10%	8.0	8.2	8.5	8.6	8.0	8.3
T4H1	5%	7.8	8.0	8.3	8.4	7.8	8.1
T4H2	10%	7.9	8.1	8.5	8.6	7.9	8.4

T1 – Control cookies, T1H1- 5% Lemon grass Cookies, T1H2- 10% Lemon grass Cookies T2H1- 5% Indian borage cookies, T2H2- 10% Indian borage cookies T2 – Control Bread T3H1- 5% Lemon grass Bread T3H2- 10% Lemon grass Bread T4H1- 5% Indian borage Bread T4H2- 10% Indian borage Bread

The T1H1, T1H2, T2H1, T2H2 had a score for Appearance as 8.5, 8.6, 8.5, and 8.9 respectively. The appearance of Lemon grass and Indian borage cookies scored well at 10% incorporation level (T1H2, T2H2) as 8.6 and 8.9 respectively. The T1H1, T1H2, T2H1, T2H2 had a score for flavour as 7.9, 8.6, 8.0 and 8.3 respectively. The flavour of Lemon grass and Indian borage cookies scored well at 10% incorporation level (T1H2, T2H2) as 8.6, 8.3 respectively. The T1H1, T1H2, T2H1, T2H2 had a score for taste as 7.5, 8.5, 8.3, and 8.6 respectively. The taste of Lemon grass and Indian borage cookies scored well at 10% incorporation level (T1H2, T2H2) as 8.5 and 8.6 respectively. The T1H1, T1H2, T2H1, T2H2 had a score for texture as 8.2, 8.2, 8.2, and 8.3 respectively. There is no high difference in texture in all the cookies. The T1H1, T1H2, T2H1, T2H2 had a score for overall acceptability as 8.3, 8.8, 8.4 and 8.9 respectively. When compared to control cookies (T0) all the sensory characters of medicinal plant extracts (Lemon grass, Indian borage) incorporated cookies were increased. The Overall acceptability of Lemon grass and Indian borage cookies scored well at 10% incorporation level (T1H2, T2H2) as 8.8 and 8.9 respectively. Lemon grass and Indian borage

extracts were incorporated at the level of 5% and 10% in Bread. The colour, appearance, flavour, taste of Lemon grass and Indian borage Bread scored well at 10% incorporation level (T3H2, T4H2) as 8.2 and 8.1 respectively. These findings are in tune with the reports of Prithwa Paul and Saurvya Bhatacharyya (2015) who reported the enhance flavour and acceptability of cookies incorporated with juice and peel powder of fresh pomegranate. The T3H1, T3H2, T4H1, T4H2 had scores for overall acceptability as 8.0, 8.3, 8.1, and 8.4 respectively. When compared to control bread (T1) all the sensory characters of medicinal plant extracts (Lemon grass, Indian borage) incorporated bread were increased. The overall acceptability of Lemon grass and Indian borage bread was found to be higher at 10% incorporation level (T3H2, T4H2) as 8.3 and 8.4 respectively. Kozlowska et al., (2019) observed that addition of herbal extracts to shortbread cookies may improve their sensory properties and extend shelf life by protecting fat against oxidation. Nabila et al., (2012) observed that biscuits supplemented with 10% germinated fenugreek (GF) had the highest content of polyphenols. Supplementation of wheat flour with fenugreek flour at 5 and 10% levels increased the vitamin B2 and -carotene contents of biscuits as documented by Garg et al., (2012).

Shelf life study

The shelf-life qualities of the developed cookies were assessed for a period of 3 months. Two sets of all the products (each containing 100g) were kept for a period of 3 months under room temperature and refrigerator storage respectively. The shelf-life qualities of the developed products were assessed for a period of 3 months. Two sets of all the products (each containing 100g) were kept for a period of 3 months under room temperature and refrigerator storage respectively. Both the sets of each product were examined visually for microbial infestation and noted down the period in which first infiltration was seen. The study revealed that the shelf-life of both control and (Lemon grass & Indian borage) extracts incorporated cookies was 3 months in room temperature and 4 months in refrigerated condition. It shows that there is no significant change in shelf-life of both the cookies.

CONCLUSION

It can be concluded that incorporation of Indian borage and Lemongrass leaf powder in cookies and bread up to 10% along with maida not only improves the texture, taste and overall acceptability but also improves the nutritive value of these products additional cost. Incorporating bioactive ingredients such as dietary fiber and phenolic antioxidants into popular

foods such as bread have grown rapidly, due to the increased consumer health awareness. Studies report that these medicinal plant powders retain the active component without decomposition even after the baking process. Due to higher nutritive value it is more effective for growing children as well as in certain therapeutic conditions like low immunity disorders. It is a cost effective supplement (at Rs.20 and Rs.25 for 50g) to overcome chronic malnutrition. Health of society can be enlivened by an effective revival of medicinal plants.

Declarations and Statements

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Conflict of interest: The Author does not have any conflict of interests to declare.

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Data availability: Author research

Author Contributions (CRediT): Writing – Review & Editing of final manuscript.

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