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Polyherbal Compositions Moisture content, Water Activity and Instrumental Colour Values

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ABSTRACT: Ayurvedic herbal medicines are increasingly being explored due to their favorable safety profile and potential benefits in cognitive impairment. Brahmi (*Bacopa monnieri*) is herb that has been extensively used as a tonic in the traditional Indian medicinal system, Ayurveda. The saponins present in brahmi are believed to be the primary compounds responsible for enhancing nerve impulse transmission. Kokum (*Garcinia indica*) is an ancient fruit that is widely consumed in the form of a refreshing beverage, known as "sharbat," in the Western Ghats region of India. This fruit tree has culinary, pharmaceutical, and nutraceutical applications.Drumstick (*Moringa oleifera*) is known for its abundant content of antioxidants, including polyphenols and carotenoids. These antioxidants hold promise in the prevention and management of various chronic degenerative conditions. The investigation of these Ayurvedic herbs and natural products, such as brahmi, kokum and drumstick, has gained momentum as potential neuroprotective and cognitive-enhancing agents. In this investigation, nutritious brahmi powder, kokum powder and drumstick powder (as a constant) were exploit at various combinations. In case of colour values the highest *L value (51.01) and *b** value (16.48) of polyherbal powder was noted in the treatment T_1 (100 % brahmi powder). The highest *a** value (16.48) noticed in T_2 (100 % kokum powder). The highest moisture content (7.87 %) and water activity (0.47) of poly herbal formulations was recorded in T_7 (60 % brahmi powder + 30 % kokum powder +10 % drumstick leaf powder).**

Keywords: brahmi, kokum, drumstick leaves, moisture.

INTRODUCTION

India's rich biodiversity and traditional knowledge of plant-based medicine hold immense promise for the discovery of new drugs to treat a variety of human ailments. Research conducted by Morales *et al.* (2017); Gahtori and Paliwal (2021) has demonstrated that traditional phytotherapy has been leveraging the therapeutic properties of numerous plant species for centuries.

Brahmi, also known as *Bacopa monnieri*, is a perennial creeping herb that is native to the wetlands of Eastern and Southern India, as well as parts of Africa, Australia, Asia, Europe, and North and South America. It is a member of the Scrophulariaceae family and is also referred to as Indian pennywort, herb of grace, or water hyssop. As reported by Gohil and Patel (2010); Ayurvedic and other herbal drugs are becoming increasingly popular, as they are often perceived to be safer than their synthetic counterparts. Among the nootropic herbs, the bacosides extracted from Bacopa monnieri stand out as notable therapeutic agents. In India, Ayurvedic medical practitioners and traditional healers have highly valued this herb, known as brahmi, for nearly 3,000 years, as highlighted by Chaudhari *et al.* (2017); Pattnaik *et al.* (2023). Brahmi is renowned for its revitalizing properties and has been used extensively in traditional Indian medicine. The widespread use of brahmi in Ayurvedic practices, along with its long-standing reputation as a therapeutic herb, suggests that it possesses significant medicinal potential. The growing interest in natural and plant-based remedies, coupled with the traditional knowledge

and scientific research on brahmi, makes it an intriguing subject for further investigation and potential development of novel therapeutic applications.

Kokum (*Garcinia indica*) is a fruit with a long-standing tradition of consumption in the Western Ghats region of India, often enjoyed in the form of a refreshing beverage known as "sharbat". This versatile fruit tree has carved out a unique place for itself in the realms of culinary, pharmaceutical, and nutraceutical applications. The kokum fruit is endowed with a spectrum of attributes, including antioxidant, acidulant, and appetite-stimulating properties. These features bestow it with the potential to address a diverse range of health concerns, such as cancer, paralysis, aging, obesity, and ulcers. The multifaceted nature of the kokum fruit, with its culinary, medicinal, and nutritional applications, has solidified its status as a valuable resource in the traditional Indian healthcare system. The fruit's rich history of use, coupled with its demonstrated therapeutic potential, makes it an intriguing subject for further scientific investigation and potential development of novel health-promoting products and interventions. The continued exploration and integration of traditional knowledge about the uses and benefits of kokum, along with rigorous scientific research, can unlock new avenues for addressing various health challenges and contribute to the expanding field of natural product-based therapies (Swami *et al.,* 2014).

The drumstick leaf (*Moringa oleifera*) is widely regarded as the most potent component of the plant. As noted by Vahini (2018), athletes often consume drumstick leaves as a discreet performance-enhancing product. The drumstick leaves are renowned for their rich antioxidant profile, containing abundant amounts of polyphenols and carotenoids. According to the observations made by Rotella *et al*. (2023), the potential of these antioxidants extends to the prevention of a variety of chronic degenerative conditions (CDDs). The high concentration of these beneficial phytochemicals in drumstick leaves underscores their medicinal value and potential applications in promoting overall health and well-being. The antioxidant properties of drumstick leaves may play a crucial role in mitigating the detrimental effects of oxidative stress, which is a contributing factor in the development of numerous chronic diseases.The use of drumstick leaves as a performance-enhancing supplement by athletes, as well as their potential in the prevention of chronic degenerative conditions, highlights the versatility and therapeutic promise of this plant. Further research and integration of drumstick leaves into health-conscious diets and supplementation regimes may yield valuable insights and benefits for individuals seeking to optimize their physical and cognitive performance, as well as maintain long-term health and well-being.

MATERIAL AND METHODS

Preparation of herbal powders. After harvesting brahmi leaves, leaves were washed and shade dried (1-2 days) and ground into powder. Kokum rinds were washed and dried at 50ºC in hot air oven. Drumstick leaves were washed with running water, shade dried and ground into powder. Different formulations were formed according to the Table 1.

Table 1: Treatment composition of polyherbal formulations.

Treatments	Brahmi powder	Kokum powder	Drumstick leaf powder
T_1	100	-	-
T_2	-	100	-
T_3	90	-	10
T_4	-	90	10
T_5	80	10	10
T_6	10	80	10
T_7	60	30	10
T_8	30	60	10

Moisture (%). A Radwag moisture analyzer (Model: MAC 50, Make Poland) was used to estimate the moisture level of powdered polyherbal mixture. The sample plate was filled with two grams of powdered polyherbal mixture. The moisture analyzer beeped to signify the measurement's endpoint and displayed the moisture content in %.

Water activity (a_w). A water activity meter (Labswift-aw, Novasina) was used to measure the water activity of the powdered polyherbal mixture. To ensure that the sample would not come into contact with the sensor located in the lid, a small amount of powder was inserted into the sample holder until it reached the designated point. Three beep sounds signaled the endpoint, which showed the digitally recorded water activity readings.

Instrumental colour values (*L* a* b).** A 45 mm (diameter) measuring tube and a white tile background were used to measure the color of the polyherbal powder using a Hunter Lab Color spectrophotometer (Colour Flex EZ, Model: CFEZ 1919, Hunter associate's laboratory, Inc., Reston). According to Caparino *et al.* (2012), the outcomes were represented as *L**, *a** and *b** values, where *L** stood for lightness, *a** for redness and greennessand *b** for yellowness and blueness.

RESULT AND DISCUSSION

Moisture content (%). Table 2 presents the facts of moisture content. The highest moisture content in poly herbal formulations was recorded in T_7 (60 % brahmi powder + 30 % kokum powder +10 % drumstick leaf powder : 7.87%) which was on par with all other treatments *viz.*, T_8 (7.84%), T_5 (7.80%), T_6 (7.76%), T_4 (7.76%) and T_2 (7.62%) except T_2 and T_3. Whereas the lowest moisture content was noticed in T_1 (100 % brahmi powder : 6.72%) followed by T_2 (100 % kokum powder : 7.62%) and T_3 (90 % brahmi powder + 10 % drumstick leaf powder : 7.34%).

When it comes to drug formulation and quality degradation, moisture content is the main culprit. Plant drugs that contain excessive moisture lead to bacterial and fungal development, metabolic reactions, and hydrolysis of individual ingredients. The formulation with less moisture content should be more stable over an extended length of time, as is probably anticipated.

Table 2 : Moisture content of polyherbal formulations.

Treatment	Moisture content (%)
T_1	6.72[c]
T_2	7.62[ab]
T_3	7.34[b]
T_4	7.76[a]
T_5	7.80[a]
T_6	7.76[a]
T_7	7.87[a]
T_8	7.84[a]
Mean	**7.59**
S. Em±	**0.05**
CD at 1%	**0.33**

Note: Similar alphabets within the column represent non-significant differences at (p<0.01)

T_1 (100 % brahmi powder); T_2 (100 % kokum powder); T_3 (90 % brahmi powder + 10 % drumstick leaf powder); T_4 (90 % kokum powder + 10 % drumstick leaf powder) ; T_5 (80 % brahmi powder + 10 % kokum powder + 10 % drumstick leaf powder); T_6 (10 % brahmi powder + 80 % kokum powder + 10 % drumstick leaf powder); T_7 (60 % brahmi powder + 30 % kokum powder + 10 % drumstick leaf powder); T_8 (30 % brahmi powder + 60 % kokum powder + 10 % drumstick leaf powder)

Reduced moisture content is always better for medication stability, according to Chandel *et al*. (2011). The current results show a moisture content of less than 10%, which is suitable for the food sector. The current results corroborate those of Aziz *et al*. (2019), who observed that the polyherbal powder's moisture content was less than 10% (w/w). As per Khandelwal (2010) findings, a plant medication's moisture content need to not exceed 14 percent.

In a different experiment, Kavya and Padmalatha (2014) found that the polyherbal formulation had a moisture content of 6.03%. Simha and Laxminarayana (2007) also observed that an ayurvedic polyherbal formulation (Nyagrodhadi churna) had a moisture content of 2.38%.

Water activity. Table 3 displayed the water activity values for the polyherbal formulations. The water activity value ranges between 0.38 and 0.47. The highest water activity was recorded in the treatment in T_7 (60 % brahmi powder + 30 % kokum powder +10 % drumstick leaf powder: 0.47), which was on par with T_8 (30 % brahmi powder + 60 % kokum powder +10 % drumstick leaf powder : 0.47), T_6 (10 % brahmi powder + 80 % kokum powder +10 % drumstick leaf powder : 0.46), T_5 (80 % brahmi powder + 10 % kokum powder +10 % drumstick leaf powder : 0.46), T_4 (90 % kokum powder +10 % drumstick leaf powder : 0.46) and T_2 (100 % kokum powder : 0.46). Whereas the lowest water activity was observed in T_1 (100 % brahmi powder : 0.38) followed by T_3 (90 % brahmi powder + 10 % drumstick leaf powder : 0.45).

Water activity is a metric that quantifies the amount of water that is free and available to microorganism development. As such, its job in guaranteeing food safety is paramount. When the water activity level drops below certain thresholds, it usually means that most harmful bacteria do not flourish (aw 0.90 for them, aw 0.70 for spoilage molds, and aw 0.60 for all other microorganisms). Water activity is frequently the most significant element, but other variables such as temperature, pH, oxygen availability and others can also affect whether or not an organism will develop in a product and at what rate. Chemical and physical qualities are also influenced by water activity (Shiby *et al.,* 2017).

Table 3 : Water activity of polyherbal formulations.

Treatment	Water activity (a_w)
T_1	0.38[c]
T_2	0.46[ab]
T_3	0.45[b]
T_4	0.46[a]
T_5	0.46[a]
T_6	0.46[a]
T_7	0.47[a]
T_8	0.47[a]
Mean	**0.45**
S. Em±	**0.80**
CD at 1%	**0.01**

Note: Similar alphabets within the column represent non-significant differences at (p<0.01)

T_1 (100 % brahmi powder); T_2 (100 % kokum powder) ; T_3 (90 % brahmi powder + 10 % drumstick leaf powder); T_4 (90 % kokum powder + 10 % drumstick leaf powder); T_5 (80 % brahmi powder + 10 % kokum powder + 10 % drumstick leaf powder); T_6 (10 % brahmi powder + 80 % kokum powder + 10 % drumstick leaf powder); T_7 (60 % brahmi powder + 30 % kokum powder + 10 % drumstick leaf powder); T_8 (30 % brahmi powder + 60 % kokum powder + 10 % drumstick leaf powder)

Foods with low water activity (<0.60) restrict the growth of vegetative microbial cells, spore germination and the manufacture of toxins by bacteria and mold. Microorganisms have an increase in lag phase and a drop in growth rate when water activity decreases. The current investigation aligned with the findings of reported that the water activity of the powdered jamun enhanced instant drink was 0.36. Dilrukshi and Senarath (2021) found comparable reports in the instant green smoothie powder.

Instrumental *L value.** Table 4 presents the information regarding the impact of compositions on *L** values of polyherbal powder.

The highest *L** value (51.01) of polyherbal powder was noted in the treatment T_1 (100 % brahmi powder) which was on par with T_3 (90 % brahmi powder + 10 % drumstick leaf powder : 50.42) followed by T_5 (80 % brahmi powder + 10 % kokum powder +10 % drumstick leaf powder : 49.74). The lowest *L** value was reported in T_2 (100 % kokum powder: 19.71) and followed by T_4 (90 % kokum powder +10 % drumstick leaf powder : 23.00).

Instrumental *a value.** The perusal of the data fromTable 4,the *a** value ranges between -1.30 to 16.48. The highest *a** value (16.48) noticed in T_2 (100 % kokum powder) followed by T_4 (90 % kokum powder +10 % drumstick leaf powder: 9.93). Whereas the lowest *a** value is observed in T_7 (60 % brahmi powder + 30 % kokum powder +10 % drumstick leaf powder : -1.30) followed by T_5 (80 % brahmi powder + 10 % kokum powder +10 % drumstick leaf powder : -2.90).

Instrumental *b value.** The *b** value of poly herbal formulations were analyzed for instrumental colour values and presented in Table 4. The *b** value ranged between 6.85 and 23.14. The highest *b** value (16.48) was recorded in T_1 (100 % brahmi powder) which was on par with T_3 (90 % brahmi powder + 10 % drumstick leaf powder : 23.13) and T_5 (80 % brahmi powder + 10 % kokum powder +10 % drumstick leaf powder : 22.86). Whereas the lowest *b** value (6.85) was noticed in T_2 (100 % kokum powder) followed by T_4 (90 % kokum powder + 10 % drumstick leaf powder: 10.46).

Perhaps because of the combination of drumstick leaf powder and brahmi, the *L** value is the greatest. Because the *L** value, which is a measure of the powder's lightness and contributes to the color measurement in the Lab color space, is added to the polyherbal formulations, the color of the herbal formulations is made lighter than it would be with the other treatments. Brahmi has a green or greenish color, and drumstick leaf powder also has a light greenish color. However, T2 (100 percent kokum powder) had the lowest *L** value, which can be attributed to the increased kokum component and its darker purple to dark pink color. As a result, kokum could lower the *L** value of a beverage.

Due to the natural color of kokum, which intensifies the redness of the polyherbal formulations, the treatments with a high percentage of kokum powder showed high values of the *a** value. Because of the color of the brahmi powder, treatments with high brahmi content indicate low *a** values. Lenin *et al.* (2021); Nayak *et al.* (2010) reported similar outcomes.

Table 4 : Instrumental colour values of polyherbal formulations.

Treatment	*L**	*a**	*b**
T_1	51.01[a]	-4.14[d]	23.14[a]
T_2	19.71[g]	16.48[a]	6.85[f]
T_3	50.42[ab]	-3.55[e]	23.13[a]
T_4	23.00[f]	9.93[b]	10.46[e]
T_5	49.74[b]	-2.90[f]	22.86[a]
T_6	28.54[e]	6.02[c]	12.28[d]
T_7	46.21[c]	-1.30[g]	21.41[b]
T_8	32.09[d]	6.06[c]	14.50[c]
Mean	**37.09**	**3.33**	**16.83**
S. Em±	**0.26**	**0.03**	**0.28**
CD at 1%	**1.03**	**0.05**	**0.88**

Note: Similar alphabets within the column represent non-significant differences at (p<0.01)

T_1 (100 % brahmi powder); T_2 (100 % kokum powder) ; T_3 (90 % brahmi powder + 10 % drumstick leaf powder); T_4 (90 % kokum powder + 10 % drumstick leaf powder); T_5 (80 % brahmi powder + 10 % kokum powder + 10 % drumstick leaf powder); T_6 (10 % brahmi powder + 80 % kokum powder + 10 % drumstick leaf powder); T_7 (60 % brahmi powder + 30 % kokum powder + 10 % drumstick leaf powder); T_8 (30 % brahmi powder + 60 % kokum powder + 10 % drumstick leaf powder)

CONCLUSIONS

As a way to create consumer-friendly food items and effectively handle food powders, polyherbal formulations has drawn a lot of interest from the food sector. Presently, the study focused on development of the herbal powder from brahmi powder, kokum powder and drumstick leaves powder with a different formulation. The study's conclusions highlight the significant room for growth in the future and the suitability of their commercialization. Even tablets can be prepared by using these herbal formulations.

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Conflict of Interest. None.

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