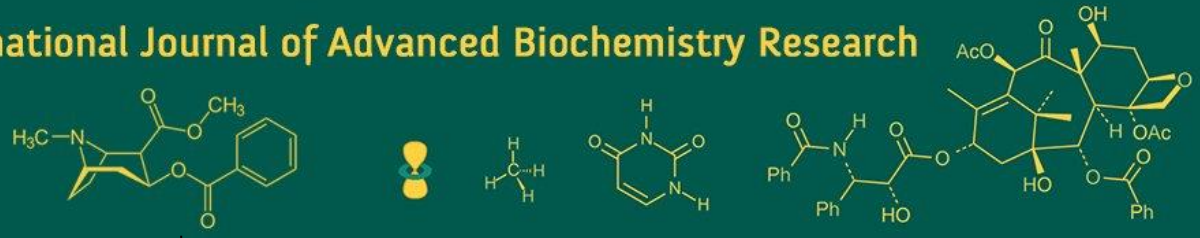
International Journal of Advanced Biochemistry Research



**ISSN Print:** 2617-4693
**ISSN Online:** 2617-4707
IJABR 2024; SP-8(2): 514-518
www.biochemjournal.com
Received: 06-12-2023
Accepted: 12-01-2024

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# A study on development cum standardization of instant soup mix using Malabar Spinach (*Basella alba*) leaves powder

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**DOI:** https://doi.org/10.33545/26174693.2024.v8.i2Sg.620

**Abstract**
The present study was conducted to develop an instant soup mix using dried Malabar spinach leaf powder. Five treatments of Malabar spinach instant soup mix containing varying proportion of Malabar spinach powder, moong dal (green gram), tomato powder, onion powder, garlic powder, ginger powder, black pepper and salt. The sensory quality and nutritional characteristics *viz*. proximate composition and minerals content of instant soup mix were analyzed. Malabar spinach instant soup mix formulated with 4 g of Malabar spinach leaves powder, 20 g of moong dal powder, and 11 g of tomato powder along with other ingredients was found most acceptable in terms of overall acceptability with score 8.0 as compared to control 8.20, respectively. The findings indicated that the incorporation with Malabar spinach leaf powder significantly enhanced the nutritional quality of the developed products. The most acceptable instant soup mix treatment (code $T_4$) high in protein (6.13-7.65%), ash (5.04-7.02%), fiber (3.37-5.89%), and low in fat (1.39-2.41%), and carbohydrates (80.02-71.34%). The formulated product is a healthy choice to help customers meet their nutritional inadequacies.

**Keywords:** Instant soup, Malabar spinach, minerals, moong dal powder

## Introduction
The world's population is expected to reach roughly 10 billion people by the year 2050, which we will have to provide into consideration on a planet with finite resources. Natural resources will be under even more stress as a result of rising food demand (Platis *et al.*, 2023) [16]. By 2050, the FAO estimates that the agricultural sector will need to produce more food on a more intensive scale in order to meet the demands of a growing global population (FAO 2018) [9]. In order to achieve the UN Sustainable Development Goals of 'no poverty', zero hunger', 'good health', and 'well-being for all', as well as to feed a world population that is expanding exponentially in developing nations, sustainable food production is of the utmost significance (Abhilash *et al.*, 2016) [1]. Research is being focused on promoting conventional green leafy vegetables. Particularly non-cultivated species are used in traditional food systems in many countries. They contribute to improving the variety and quality of micronutrients in local diets, as well as reducing the burden of "hidden hunger", which would improve health. These non-cultivated species are often easily accessible and inexpensive (Icard-Verniere *et al.*, 2015) [12]. Additionally, conventional green leafy vegetables are underutilized due to a lack of understanding of their nutritional benefits and a growing indifference to in foods among the younger generation. Although underutilized vegetables are important locally or regionally and have historically been used for their fruit, fiber, fodder, oil, or medicinal properties, they typically lack national recognition and appreciation. Underutilized veggies are nutrient-dense and well-suited to low-input farming (Godfray *et al.*, 2010) [11].

Malabar spinach (*Basella alba*) is an underutilized perennial leafy vegetable belongs to *Basellaceae* family. Malabar spinach is a leafy vine that is native to tropical Asia and is widely grown in Asia and Africa. Southeast Asia, New Guinea, and the Indian subcontinent are its native regions. It is also known as climbing spinach, vine spinach, Indian spinach, and Ceylon spinach (Ernst. 2017) [8]. In Ayurveda, it is referred to as "Upodika". In India, generally it is called poi. It is typically grown as a pot herb throughout all of India because it is relatively easy to grown, with the exception of hilly areas. Malabar spinach refers to three species that differ from one another in terms of growth habits and leaf shapes. 1. *Basella alba* has dark green leaves; 2. *Basella rubra* has reddish oval to round leaves; 3. *Basella cordifolia*, has dark green cordate leaves (Fren. 2014) [10].

Malabar spinach needs nearly minimal maintenance apart from climbing the stem on a regular basis because it has a climbing stem structure. Because the roots are not exceptionally sturdy, the root collars must be fully filled. Malabar spinach is a simple plant to grow in the right soil, and environment. Long days are advised for cultivation in a hot, sunny area. High reasonable humidity is crucial for agriculture because it prevents flowering which makes leaves bitter. When the temperature is between 32 °C and 26 °C, the plant develops at its maximum potential. Areas with wind protection and direct or indirect sunlight are good for production (Acikgoz & Adiloglu. 2018) [3]. According to some studies, the mucilage found in Malabar spinach has hypoglycemic properties. It has been stated that it possesses anti-inflammatory, healing, and gastroprotective properties. The medication is used in Ayurveda for a number of conditions, including mada (intoxication), anidra (insomnia), paadadari (cracked feet), jvara (fever), pravaahikaa (dysentery), arshas (haemorrhoids), ziatapitta (urticaria), vranasotha (inflammatory), arbuda (tumours), and raktapitta (bleeding disorders) (Acharya, 2016) [2]. As a safe laxative for youngsters and pregnant women, decoction of the leaves is advised. Anandarajagopal *et al.,* (2011) [6] reported that the paste of root of red *B. alba* along with rice washed water is taken in the morning in empty stomach for one month to cure irregular periods by the rural people of Orissa, India. Leaves of *B. alba* is used for the treatment of hypertension by Nigerians in Lagos, and malaria in cameroonian folk medicine. According to the USDA (U.S. Department of Agriculture), edible leaves of Malabar spinach contain 93% water, 3% carbohydrates, 2% protein content, and minimal fat. Malabar spinach has significant amounts of antioxidants, iron, calcium, and magnesium, as well as vitamins, particularly vitamins A, C, and B-complex. It also contains plenty of nutritional fibre (Singh *et al.,* 2018) [19]. Malabar spinach leaves have 92.68g/100g moisture, 1.57g/100g ash, 1.09 g/100g protein, 0.45g/100g total fat, 2.21g/100g total fibre, 2.01g/100g carbohydrate (Longvah *et al.,* 2017) [13]. According to Soriano *et al.* (2020) [20], Malabar spinach leaf powder has 12.06% moisture, 16.17% ash, 10.36% crude fibre, 21.38% crude protein and 40.03% carbohydrate content. Soup is one of the conventional foods that can be categorized as an appetizer, hot food during cold and illness. Commercially prepared instant soups have replaced homemade soups in the modern world as preparing soups is a time-consuming process (Niththiya *et al.,* 2014) [14]. Soup is usually prepared by combining the ingredients like veggies and green leaves with juice, water, or other liquid. Hot soup is defined as simmering solid ingredients in a liquid in a pot until the flavours emerge and a stock is formed. Rice, lentils, flour and grains are used to thicken soups and stock. Instant soup mixes are useful for working families, hospitals, and institutions. Malabar spinach leaves are perishable in nature; it cannot be stored for a longer period. Therefore, in order to maximize its use, an effort has been made for development of instant soup premix using Malabar spinach leaf powder. The objective of this study is to develop an instant soup mix using Malabar spinach leaf powder as well as to determine the nutritional and sensory quality of the instant soup mix.

## Materials and Methods

### Procurement of raw material

Malabar spinach leaves were collected from a local farmer of Ayodhya (District), Uttar Pradesh, India. Fresh tomato, onion, and garlic, split green gram ginger powder were purchased from local market of Kanpur.

### Processing of Malabar spinach leaves

Malabar spinach leaves were thoroughly cleaned to remove dust, dirt, and other foreign material. Malabar spinach leaves were washed in running water and then dried in oven at 50 °C for 6 hours to prevent deterioration from biological agent. The fully dried leaves were subjected to grinding. The ground material was passed through 60 mesh sieve. Malabar spinach leaves Powder was stored in air tight glass container for further study.

### Preparation of ingredients

Tomatoes, garlic, and onion powder were used as ingredient for preparation of instant soup mix. Tomatoes, garlic, and onion were washed under running water for removal of dust, dirt and other foreign material, and processed into powder from by using standard methods of Srivastava (2010) [22], Pawar (2019) [15], and Sangwan (2010) [18], respectively.

### Formulation of Malabar spinach instant soup mix

Five treatments of Malabar spinach instant soup mix containing varying proportions of Malabar spinach leaf powder were prepared by dry mixing of Malabar spinach leaf powder, tomato powder, and moong dal powder, onion powder, garlic powder, ginger powder, black pepper powder, corn flour, dehydrated carrot, and salt (Table1). Amal *et al.* (2014) [4] method was applied to prepare all experimental samples with minor modifications. Malabar spinach soup mix can be prepared from this premix, for this instant soup mix (10g) added in boiling water (200ml) and cook at low flame for five minutes with stirring.

**Table 1:** Combination of ingredients used in the development of Malabar spinach soup mix

| Ingredients (g) | $T_0$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|---|
| MSLP* | 0 | 4 | 6 | 8 | 10 |
| Tomato powder (TP) | 13 | 11 | 9 | 7 | 5 |
| Moong dal powder (MDP) | 22 | 20 | 20 | 20 | 20 |
| Onion powder | 15 | 15 | 15 | 15 | 15 |
| Garlic powder | 10 | 10 | 10 | 10 | 10 |
| Ginger powder | 10 | 10 | 10 | 10 | 10 |
| Black pepper powder | 5 | 5 | 5 | 5 | 5 |
| Corn flour | 10 | 10 | 10 | 10 | 10 |
| Salt | 10 | 10 | 10 | 10 | 10 |
| Dehydrated carrot | 5 | 5 | 5 | 5 | 5 |
| Total | 100 | 100 | 100 | 100 | 100 |

*MSLP; Malabar spinach leaves powder

**Nutritional quality of Malabar spinach soup mix**

**Proximate composition of Malabar spinach instant soup mix-** All the estimations were done in triplicates. Moisture, crude protein, total ash, crude fat and crude fibre were estimated in triplicate by AOAC 1995 [7]. Carbohydrate (%) was calculated as 100- {protein (%) + crude fat (%) + moisture (%) + ash (%) + crude fibre (%) and energy as (4×protein% + 9×fat% + 4× carbohydrate %)

**Minerals:** Minerals *viz* calcium and iron in the muffins sample were estimated in triplicate. Calcium content of muffin sample was estimated by titrametric method of AOAC (1995) [7]. Iron and zinc were estimated using atomic absorption spectrophotometer samples. Representative samples in liquid form were sprayed into the flame of an atomic absorption spectrophotometer and the absorption or emission of the mineral to be analyzed was measured at a specific wavelength.

**Sensory analysis**

Malabar spinach soup with different combination of ingredients was evaluated for sensory quality by score card method (Amerine *et al.*, 1965) [5].

**Statistical analysis**

The analyzed values of nutrients, and sensory qualities, of food products were subjected to one way ANOVA test in order to measure significant differences.

**Results and Discussion**

**Sensory quality of Malabar spinach instant soup mix by score card method**

**Table 2:** Rating for preference of Malabar spinach instant soup mix and control soup mix by score card method

| Parameter | Product code | | | | | C.D. at 5% | S.Em | S/NS |
|---|---|---|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ | | | |
| Taste | 8.40±0.46 | 8.05±0.35 | 7.15±0.58 | 5.75±0.50 | 4.55±0.49 | 0.46 | 0.16 | S |
| Appearance | 8.10±0.38 | 7.85±0.54 | 7.40±0.69 | 6.00±0.54 | 5.00±0.82 | 0.43 | 0.15 | S |
| Aroma | 8.05±0.20 | 7.95±0.53 | 7.10±0.63 | 6.00±0.26 | 5.50±0.49 | 0.42 | 0.15 | S |
| Consistency | 8.30±0.42 | 8.20±0.52 | 7.05±0.73 | 6.75±0.76 | 6.00±0.39 | 0.45 | 0.16 | S |
| Aftertaste | 8.75±0.45 | 7.50±0.73 | 6.60±0.48 | 5.95±0.56 | 5.05±0.72 | 0.38 | 0.13 | S |
| Overall acceptability | 8.20±0.46 | 8.00±0.49 | 6.75±0.46 | 6.05±0.74 | 5.10±0.60 | 0.40 | 0.14 | S |

Values are the mean ± SD, Control (TP: MDP, 13:22g & 0g MSLP), $T_1$-(TP: MDP, 11:20g & 04g MSLP), $T_2$- (TP: MDP, 09:20g & 06g MSLP), $T_3$- (TP: MDP, 07:20g & 08g MSLP), $T_4$- (TP: MDP, 5:20g & 10g, MSLP)

*S/NS signifies significant and non-significant difference, respectively, S.Em.- standard error of mean, C.D. - critical difference

The findings of sensory evaluation are given in Table 2. For all sensory qualities, control treatment ($T_0$) obtained the highest score, while the treatment $T_4$ had the lowest score followed by treatment $T_3$, $T_2$ and $T_1$. The score of control treatment for taste, appearance, Aroma, consistency, after taste and over all acceptability were 8.40, 8.10, 8.05, 8.30, 8.75, and 8.20, respectively (Table 2). Among the Malabar spinach incorporated instant soup mix formulations the treatment $T_1$ scored maximum than other treatments for all the sensory attributes *viz*., for taste (8.05), appearance (7.85), aroma (7.95), consistency (8.20), after taste (7.50) and over all acceptability (8.00). All the treatments differed significantly from each other (Table 2).

**Nutritional quality of Malabar spinach instant soup mix**

**Proximate composition**

Proximate composition and energy values of different treatments of Malabar spinach instant soup mix are given in Table 3.

**Moisture content:** Moisture content of Malabar spinach instant soup mix increased from 4.04 to 5.65% with increasing level of Malabar spinach leaves powder while control instant soup mix labeled as $T_0$ had 3.37% of moisture content. The statistical analysis of the data revealed a significant difference between the control instant soup mix and the Malabar spinach instant soup (Table 3). The moisture content of Malabar spinach instant soup mix increased with addition of Malabar spinach powder. Soriano *et al*. (2020) [20] reported 12.06 Percent of moisture content in Malabar spinach leaves powder. According to the study by Srivastava *et al*. (2019) [21], the moisture content of instant soup premixes formulated with mushroom powder ranged from 2.86 to 4.36%. These findings are in line with the findings of Rokhsana *et al*. (2007) [17] who reported the moisture content in corn based, rice based, and wheat based instant soup premix was found to be 7.00%, 6.66% and 6.99%, respectively.

**Total ash:** Total ash content of Malabar spinach instant soup mix increased from 5.04 to 7.02% with increasing level of Malabar spinach leaves powder while control instant soup mix labeled as T0 had 4.28 of moisture content (Table 3). The ash content of optimized Malabar spinach instant soup was significantly increased with the addition of Malabar spinach leaves powder, moong dal powder, and tomato powder. This could be due to the higher ash content of Malabar spinach leaves powder and moong dal powder. These results agreed with the findings of Rokhsana *et al*. (2007) [17] who reported the ash content in corn based soup, rice based soup, and wheat soup powder was found to be 4.5%, 5.79%, and 4.82%, respectively. Soriano *et al*. (2020) [20] observed 16.17 Percent of ash content in Malabar spinach leaves powder.

**Crude protein:** The present study evaluated the crude protein content of various treatments of Malabar spinach instant soup treatments in comparison to control instant soup mix. The results showed that treatment $T_4$ had the highest crude protein content at 7.65 Percent, followed by $T_3$, $T_2$, and $T_1$, with crude protein contents of 7.22%, 6.75%, and 6.13%, respectively. In contrast, the crude protein content in control instant soup mix ($T_0$) was 6.02 of. These findings revealed that Malabar spinach instant soup treatments has a significantly higher crude protein content than control instant soup mix (Table 3 and Fig 8 (a)). The crude protein content of Malabar spinach instant soup treatments was increased with the addition of Malabar spinach leaves powder, and moong dal powder. Srivastava *et al*. (2019) [21] found that instant soup premixes formulated with mushroom

powder had a crude protein content ranging from 8.15 to 15.41 Percent.

**Crude fat:** Crude fat content of Malabar spinach instant soup mix increased from 1.39 to 2.41% with increasing level of Malabar spinach leaves powder while crude fat content in control instant soup mix was found to be 1.10% (Table 3). Srivastava *et al*. (2019) [21] conducted a study on instant soup premixes formulated with mushroom powder. The study found that the crude fat content ranged from 1.13 to 3.18%. Rokhsana *et al*. (2007) [17] also presented similar results, the fat content in corn based soup, rice based soup, and wheat soup powder was found to be 1.26%, 1.40%, and 1.25%, respectively.

**Crude fiber:** Crude fiber content of Malabar spinach instant soup mix was also increasing from 3.37 to 5.89% with increasing level of Malabar spinach leaves powder. The control instant soup mix ($T_0$) had a crude fibre content of 2.15 Percent which was lowest among all the treatment. The results showed that there was a significant difference between the different treatments of Malabar spinach instant soup when compared to the control (Table 3). The results were compared with the study of Soriano *et al*. (2020) [20] mentioned that the crude fibre content in Malabar spinach leaves powder was found 4.66 Percent. Srivastava *et al*. (2019) [21] reported that the crude fibre content of curry instant soup premixes formulated with mushroom powder ranged from 2.07 to 7.88%.

**Carbohydrate by difference:** Carbohydrate content of Malabar spinach instant soup mix decreased from 80.02 to 71.34% with increasing level of Malabar spinach leaves powder which indicates a significant reduction in carbohydrate content compared to the control instant soup mix ($T_0$). The control soup mix showed comparatively higher carbohydrate content, which was 83.09 Percent (Table 3). The results were compared with the study of Soriano *et al*. (2020) [20] mentioned that the carbohydrate content in Malabar spinach leaves powder was found 40.03 Percent. Srivastava *et al*. (2019) [21] found that curry instant soup premixes formulated with mushroom powder had a carbohydrate content ranging from 64.23 to 72.03. Rokhsana *et al*. (2007) [17] also observed similar findings that the carbohydrate content in corn based soup, rice based soup, and wheat soup powder was found to be 66.37%, 65.08%, and 66.87%, respectively.

**Physiological energy value:** Table 3 clearly shows that all Malabar spinach instant soup mix treatments ($T_1$, $T_2$, $T_3$, and $T_4$) had significantly lower physiological energy content than the control instant soup mix ($T_0$), with the highest energy content observed in $T_0$ (366.13 Kcal/100g). Energy content of Malabar spinach instant soup mix was also decreasing from 356.82 to 337.76 kcal with increasing level of Malabar spinach leaves powder (Table 3 and Fig 2 (b)). Srivastava *et al*. (2019) [21] observed that instant soup premixes formulated with mushroom powder had a carbohydrate content ranging from 328.79 to 348.36 kcal/100g.

**Minerals**

**Calcium:** Calcium content of Malabar spinach instant soup mix treatment ($T_1$, $T_1$, $T_3$, & $T_4$) ranged from 22.84 to 29.05mg/100g (Table 4). Treatment $T_4$ exhibited maximum calcium content (29.05mg/100g) followed by $T_3$, $T_2$, $T_1$, and control ($T_0$) formulation with minimum calcium content (22.52mg/100g).

**Iron:** It is clear from Table 4 that the iron content ranged from 1.50 to 2.80 mg/100g in different treatment of Malabar spinach instant soup mix. Treatment $T_0$ (0.79) had significantly lower iron content as compared to other treatments and it was statistically inferior to rest.

**Zinc**

The zinc content of Malabar spinach instant soup mix ranged from 0.97 to 1.16 mg/100g in various treatments. Treatment $T_4$ exhibits highest zinc content (1.16 mg/100g) followed by $T_3$, $T_2$, $T_1$ and control treatment ($T_0$) had lowest zinc content (0.90mg/100g). All treatments differed significantly from each other (Table 4).

**Table 3:** Proximate composition of Malabar spinach Instant soup mix

| Proximate Composition (%) | Treatments | | | | | S. Em. | C.D.@5% | S/NS |
|---|---|---|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ | | | |
| Moisture | 3.37±0.02 | 4.04±0.02 | 4.54±0.16 | 5.04±0.02 | 5.65±0.04 | 0.05 | 0.14 | S |
| Ash | 4.28±0.06 | 5.04±0.03 | 5.76±0.15 | 6.44±0.03 | 7.02±0.02 | 0.04 | 0.14 | S |
| Crude Protein | 6.02±0.02 | 6.13±0.03 | 6.75±0.05 | 7.22±0.01 | 7.65±0.09 | 0.03 | 0.09 | S |
| Crude Fat | 1.10±0.02 | 1.39±0.03 | 1.59±0.01 | 2.02±0.06 | 2.41±0.36 | 0.03 | 0.10 | S |
| Crude Fiber | 2.15±0.12 | 3.37±0.39 | 4.29±0.09 | 4.82±0.30 | 5.89±0.11 | 0.14 | 0.44 | S |
| Carbohydrate by difference | 83.09±0.07 | 80.02±0.49 | 77.05±0.11 | 74.31±0.08 | 71.34±0.30 | 0.15 | 0.46 | S |
| Energy (kcal/100g) | 366.13±0.11 | 356.82±1.52 | 349.53±0.37 | 344.12±0.38 | 337.76±0.75 | 0.46 | 1.45 | S |

Values are the mean ± SD, Control (TP: MDP, 13:22g & 0g MSLP), $T_1$-(TP: MDP, 11:20g & 04g MSLP), $T_2$- (TP: MDP, 09:20g & 06g MSLP), $T_3$-(TP: MDP, 07:20g & 08g MSLP), $T_4$- (TP: MDP, 5:20g & 10g, MSLP)

*S/NS signifies significant and non-significant difference, respectively, S.Em.- standard error of mean, C.D. - critical difference

**Table 4:** Mineral composition of Malabar spinach instant soup mix

| Parameter | $T_0$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ | S. Em. | C.D.@ 5% | S/NS |
|---|---|---|---|---|---|---|---|---|
| Calcium | 22.52±0.42 | 22.84±0.60 | 24.51±0.43 | 27.11±0.07 | 29.05±0.05 | 0.22 | 0.70 | S |
| Iron | 0.79±0.02 | 1.50±0.05 | 1.93±0.06 | 2.30±0.2 | 2.80±0.10 | 0.06 | 0.20 | S |
| Zinc | 0.90±0.06 | 0.97±0.05 | 1.07±0.03 | 1.09±0.01 | 1.16±0.02 | 0.02 | 0.08 | S |

Values are the mean ± SD, Control (TP: MDP, 13:22g & 0g MSLP), $T_1$-(TP:MDP, 11:20g & 04g MSLP), $T_2$- -(TP:MDP, 09:20g & 06g MSLP), $T_3$- (TP:MDP, 07:20g & 08g MSLP), $T_4$- (TP:MDP, 5:20g & 10g, MSLP)

*S/NS signifies significant and non-significant difference, respectively, S.Em.- standard error of mean, C.D. - critical difference

## Conclusion

From the present study it can be concluded that the enriched Malabar spinach-based soup mix prepared by drying can be adopted for the development of soup mix. Malabar spinach can be added to instant soup mix to increase its nutritional quality. Among the five combinations, the treatment coded as $T_1$ was found best in sensory attributes. The developed instant soup mix is more nutritious that the traditional instant soup mix. Addition of Malabar spinach leaf powder in instant soup mix increase the calcium, iron and zinc content in the developed products. All treatments of Malabar Spinach Instant Soup Mix were found to be a more nutritious and healthy choice for consumers who rely mostly on ready-to-cook food products.

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