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DEVELOPMENT AND EVALUATION OF NUTRITIOUS PREMIX INCORPORATED WITH GRAPE POMACE POWDER

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ABSTRACT

Experiment on "Development and evaluation of valorised products from grape var. Manjari Medika" was conducted in the Department of Postharvest Management, College of Horticulture, Bagalkot, Karnataka during the year 2024-25. The study focused on developing and evaluating valorised products incorporated with grape pomace powder. The products were assessed for their physico chemical properties, sensory attributes and storage stability. Nutritious premix incorporated with grape pomace powder was prepared by varying grape pomace powder (5.00 to 25.00 g). The treatment T_6 (25.00 g of grape pomace powder) was found to be superior with WAC (2.49 g/g), WSI (4.02 %), SP (3.58 g/mL), BD (0.480 g/mL), color values (*L**: 41.61, *a**: 4.02 and *b**: 3.25), proximate composition (moisture: 9.58 g/100g, ash: 2.61 g/100g, protein: 13.01 g/100g, fat: 2.894 g/100g and fibre: 16.42 g/100g) and minerals (calcium: 136.77 mg/100g, magnesium: 157.49 mg/100g, iron: 4.691 mg/100g and zinc: 2.98 mg/100g).
Keywords **:** Nutritious, Grape pomace powder, Premix, Proximate.

Introduction

Currently, ICAR-NRCG developed a grape hybrid, Pusa Navrang × Flame Seedless which has been released as 'Manjari Medika'. It is a teinturier (coloured pulp apart from coloured skin) variety suitable for juice making. The variety matures in 130-140 days after fruit pruning and yields 22-25 t/ha. The berry diameter is 12-14 mm and the TSS is 20-22 ^{0}B. This variety is one of the most suitable variety for processing industry and has proposed a 'zero waste' processing model, so that none of the bi-products is underutilized. It contains exceptionally high amount of anthocyanin (4.0 g / kg) which have antioxidant and anti-cancerous properties (Sharma *et al*., 2020).

Multigrain composite mixes are prepared by combining cereals, millets and oilseeds through various processing methods. Blending these grains enhances their nutritional, functional and sensory qualities. Multigrain flour provides multiple health benefits, as it is high in fiber, vitamin richness and supports weight management and digestive wellness. (Chakraborty *et al*., 2024). Multigrains combine the strengths of diverse cereals and millets, offering a balanced nutrient profile.

In today's lifestyle, the frequent consumption of processed snacks and calorie-dense foods has led to increased health concerns, including obesity, diabetes and cardiovascular disorders. Hence, it is essential to formulate healthy and nutrient-rich alternatives. The current study focuses on developing and standardizing an innovative premix by combining multigrain with

grape pomace powder to create functional and nutritious products.

Materials and Methods

Procurement of raw material

Fruit, such as grape (var. Manjari Medika), were purchased from the local farmer of Afzalpur, Kalburagi, for the experiment. Multigrain flours, including wheat, barnyard millet, oats, soybean and chia seed flour, were procured directly from a local market.

Preparation of grape pomace powder

Grape pomace, consisting of skin and seeds remaining after juice extraction, was directly dried in a tray dryer at a controlled temperature until a stable weight was obtained. The dried samples were pulverized and sieved to obtain finely powdered grape pomace.

Physical properties of nutritious premix

The physical properties such as water absorption capacity was determined using the method of Abbey and Ibeh (1988), Water solubility index was determined by using the Kainuma *et al*. (1967) method, swelling power was determined using the Leach *et al*. (1959) method and bulk density was determined by using method of Seifu *et al*. (2018).

Table 1: Nutritious premix incorporated with grape (var. Manjari Medika) pomace powder.

Ingredients	T_1	T_2	T_3	T_4	T_5	T_6
Whole wheat flour (g)	70.0	65.0	60.0	55.0	50.0	45.0
Barn yard millet (g)	10.0	10.0	10.0	10.0	10.0	10.0
Chia seeds (g)	10.0	10.0	10.0	10.0	10.0	10.0
Defatted soya flour (g)	5.0	5.0	5.0	5.0	5.0	5.0
Oats flour (g)	5.0	5.0	5.0	5.0	5.0	5.0
Grape pomace powder (g)	-	5.0	10.0	15.0	20.0	25.0

Proximate composition of nutritious premix

The proximate composition was analyzed using standard methods: moisture content was determined with a Radwag moisture analyzer (Model MAC 50, Poland), crude protein by the Micro Kjeldahl method and crude fat with an automatic Soxhlet apparatus (SOCS PLUS; Pelican Equipments, Chennai) as described by Ojure and Quadri (2012). Crude fiber was estimated using the Fibra Plus-FES-6 instrument, ash content with a muffle furnace and carbohydrates according to AOAC (1980). The calorific value was calculated using the differential method outlined by BeMiller (2017).

Minerals

The mineral content of the nutritious premix enriched with grape pomace powder such as calcium and magnesium were measured using the complexometric titration method described by Jackson (1973), while iron and zinc were determined using an atomic absorption spectrophotometer according to the method of Lindsay and Norvell (1978).

Statistical analysis

Completely Randomized Design (CRD) with one-way ANOVA, utilizing the Web Agri Stat Package (WASP) version 2 (Jangam and Thali, 2010) was used to examine the data on the physico-chemical properties and sensory qualities of burfi and porridge. $P = 0.01$ was the significance level applied to the tests. The tests used a significance level of $p = 0.01$. Critical difference values were calculated when the F-test indicated significance.

Result and Discussion

Physical properties of multigrain premix

Water absorption capacity (g/g)

The data indicated a significant variation among the treatments in terms of water absorption capacity (Table 2). The water absorption capacity was ranged from 2.21 to 2.49 g/g with a mean of 2.34 g/g. However, maximun water absorption capacity was found in T_6 with 2.49g/g which was followed by T_5 with 2.42g/g and the minimum water absorption capacity was observed in T_1 with 2.21g/g. WAC is the ability of an ingredient to absorb and retain water, usually expressed per unit weight of dry sample. It affects dough handling, texture, yield, moisture retention and overall product quality and shelf life (Chandra *et al*., 2015). An increasing trend in WAC values was noted with higher concentration of grape pomace powder attributed to its hydrophilic nature and high fiber content of grape pomace powder. These findings are align with the results reported by Alshawi (2024) who studied that increasing WAC of wheat flour enriched with grape pomace powder.

Water solubility index (%)

The results pertaining to water solubility index showed significant difference among the treatments (Table 2). Water solubility index ranged from 4.62 to 4.02 per cent. The maximum water solubility index was observed in T_1 with 4.62 % followed by T_2 with 4.31 % and minimum water solubility index was found in T_6 with 4.02 %). The Water Solubility Index (WSI) indicates the proportion of dry matter that dissolves in water, reflecting soluble starch, proteins and sugars (Rashid *et al*., 2015). WSI decreased with higher levels of grape pomace and other ingredients, likely due to their high insoluble fiber (cellulose, lignin, hemicellulose) content, which reduces water solubility. The results were in parallel with Mironeasa *et al, (*2024) where grape pomace powder reduces the water solubility characteristics of the snacks.

Swelling power (g/mL)

Table 2 depicts the swelling power of nutritious premix incorporated with grape pomace powder. Swelling power ranged from 3.58 to 4.27 g/mL. The maximum swelling power was found in T_1 with 4.27 g/mL followed by T_2 with 4.01 g/mL and minimum swelling power was found in T_6 with 3.58 g/mL. The reduction in swelling power with increasing grape pomace powder concentration is due to its high fiber content, which binds water without swelling and polyphenols that interact with starch, impeding gelatinization and granule expansion. A similar trend was reported by Tolve *et al*. (2020) where they have studied the effect of grape pomace on durum wheat pasta.

Bulk density (g/mL)

Table 2 depicts the bulk density of the nutritious premix incorporated with grape pomace powder. The mean value of bulk density was recorded 0.502 g/mL. The highest bulk density was noticed in T_1 with 0.531 g/mL and least was noticed in T_6 with 0.480 g/mL. The decrease in bulk density with grape pomace powder addition is attributed to its light, fibrous and porous structure, which introduces more air spaces and reduces particle packing efficiency, resulting in a lower mass per unit volume. The results were in parallel with Altan *et al*. (2008)) reported that barley–grape pomace blends enhances the bulk density.

Colour value (*L, *a** and *b**)**

The data representing colour values (*L**, *a** and *b**) of premix incorporated with grape pomace powder is represented in Table 3.

L* **value**

The physical characteristics of the product, as shown in Table 3, revealed a reddish appearance with lightness value which was ranged from 41.61 to 53.04 with a mean value of 46.61. The highest value of *L** was observed in T_1 with 53.04 followed by T_2 with 49.32 and least was observed in T_6 with 41.61. The decreasing trend of *L** value was due to dark pigments present in grape pomace (anthocyanins and polyphenols).

a* **value**

The redness (*a**) value of nutritious premix incorporated with grape pomace powder varied from 2.54 to 4.02 (Table 3). The significant high redness value was found in T_6 with 4.02 followed by T_5 with 3.88. However, the least was found in T_1 with 2.54. A significant rise in *a** value was observed with the increase in grape pomace powder due to the purple-red pigments from anthocyanins.

b* **value**

The b* value, indicating the yellowness of the product, showed a range between 3.25 to 7.41 (Table 3). The highest *b** value was found in T_1 with 7.41 followed by T_2 with 5.02 and lowest was found in T_6 with 3.25. The significant decrease in *b** values due to anthocyanin pigments present in grape pomace powder masking the product's yellow tones. Similar trend was observed in findings of Tolve *et al.* (2020) where addition of grape pomace powder increased *a**, decreased *L** and *b** value of pasta.

Proximate composition of multigrain premix

Moisture (g/100 g)

Table 4 depicts the moisture content of nutritious premix incorporated with grape pomace powder. The moisture ranged from 9.01 to 9.58 g/100 g. However highest moisture was found in T_6 with 9.58 g/100g followed by T_5 with 9.53 g/100g and least was found in T_1 with 9.01 g/100g. The significant increase in moisture content is attributed to the high water absorption capacity of grape pomace fibers, which effectively retain water. The observations correspond with Maner *et al*., (2017) reported that replacement of wheat flour with grape pomace powder enhances the moisture content of cookies.

Ash (g/100 g)

The data illustrating the ash content of nutritious premix incorporated with grape pomace powder is represented in Table 4. The ash content ranged from 2.11 to 2.61 g/100 g with a mean value of 2.49 g/100g. However, the highest ash content was found in T_6 with

2.61 g/100g and the least ash content was observed in T_1 with 2.11 g/100g. The rising trend of ash content may be due to the increasing concentration of grape pomace powder, which is rich in minerals, thereby elevating the overall ash levels. Troilo *et al*. (2022) reported similar results where ash content increases with incorporation of grape pomace powder in muffin premix.

Protein (g/100 g)

The analysis revealed the significant difference between the treatments with respect to protein content of nutritious premix incorporated with grape pomace powder (Table 4). The protein ranged from 13.01 to 14.09 g/100 g. However highest protein was found in T_1 with 14.09 g/100g and lowest protein was found in T_6 with 13.01 g/100g. Protein content decreased as grape pomace powder levels increased because the protein-rich flour was partially replaced by grape pomace powder, which is high in fiber but low in protein. Comparable findings were also noted by Reis *et al*. (2014) showed that with addition of apple pomace, there was decrease in protein content in baked products.

Fat (g/100 g)

The data with respect to fat content of nutritious premix incorporated with grape pomace powder ranged from 2.831 to 2.894 g/100 g (Table 4). The highest fat was found in T_6 with 2.894 g/100 g which was on par with subsequent treatments incorporated with grape pomace powder and the least fat content was found in T_1 with 2.831 g/100g. The increase in fat from T_1 to T_2 is likely because grape seeds are high in fat and the addition of grape pomace powder introduces these natural fats, thereby increasing the overall fat content. The results are similar to the investigation of Vasekova *et al*. (2020) studied the fatty acid profile of grape pomace.

Fibre (g/100 g)

The result concerning fibre content of the nutritious premix incorporated with grape pomace powder is depicted in Table 4. The fibre values varied from 13.12 to 16.42 g/100 g. However, the highest fibre value was recorded in T_6 with 16.42 g/100g and lowest was recorded in T_1 with 13.12 g/100g. The significant increase in fiber content is directly attributed to the high fiber content of the grape pomace powder used in the formulation. The results were in parallel with Nakov *et al*. (2020) where there is increased dietary fiber content in cakes enriched with grape pomace powder.

Carbohydrate (g/100 g)

Table 5 provides a comprehensive overview of carbohydrate content of nutritious premix incorporated with grape pomace powder. The carbohydrate value ranged from 55.46 to 59.93 g/100g. However, the highest carbohydrate value was recorded in T_1 with 59.93 g/100g and the least was found in T_6 with 55.46 g/100g. The carbohydrate content decreases with increasing grape pomace powder concentration due to the higher levels of moisture, fiber and residual fat, while grape pomace powder itself contains relatively low amounts of digestible carbohydrates. Antoniolli *et al*. (2024) reported that incorporation of grape pomace reduces the carbohydrate content in muffins.

Energy (kcal/ 100 g)

The data concerning the energy value of nutritious premix incorporated with grape pomace powder as influenced by the treatments are presented in Table 5 which ranged from 299.96 to 316.90 kcal/100 g. However, the maximum energy value was recorded in T_1 with 316.90 kcal/100g and minimum energy value was recorded in T_6 with 299.96 kcal/100g). The reduction in energy on increasing grape pomace powder is mainly due to decreased carbohydrate level.

Minerals (calcium, magnesium, iron and zinc)

Calcium (mg/100 g)

The data pertaining to calcium content of nutritious premix incorporated with grape pomace powder is depicted in Table 6. The calcium content ranged from 109.15 to 136.77 mg/100 g. However, highest calcium content was recorded in T_6 with 136.77 mg/100g followed by T_5 with 131.83 mg/100g and the lowest calcium content was recorded in T_1 with 109.15 mg/100g.

Magnesium (mg/100 g)

The data on magnesium content of nutritious premix incorporated with grape pomace powder is illustrated in Table 6. The magnesium content showed significant difference among the treatments which varied between 145.73 - 157.49 mg/100 g. The treatment T_6 (157.49 mg/100g) showed highest magnesium content followed by T_5 (155.52 mg/100g) and T_1 (145.73 mg/100g) showed lowest magnesium content.

Iron (mg/100 g)

The data pertaining to iron content of nutritious premix incorporated with grape pomace powder is depicted in Table 6. The iron content ranged from 4.620 to 4.691 mg/100 g. However, the significant maximum iron content was recorded in T_6 with 4.691 mg/100g and the significant minimum iron content was recorded in T_1 with 4.620 mg/100g.

Zinc (mg/100 g)

The data on zinc content of nutritious premix incorporated with grape pomace powder is illustrated in Table 6. The zinc content varied between 2.77 - 2.98 mg/100 g. The significant highest zinc content was observed in T_6 with 2.98 mg/100g which was on par with T_5 (2.96 mg/100g) and the lowest zinc content was recorded in T_1 with 2.77 mg/100g.

Mineral content were increased with increase in the concentration of grape pomace powder, this is due to grape pomace provides abundant minerals such as calcium, magnesium, iron and zinc, predominantly stored in its skin and seed portions. The same trend was noticed in investigation of Raju (2021) where amla pomace powder shows significantly high mineral content. In another study of Martirosyan *et al*. (2025) where observed that incorporating grape peel significantly enhanced mineral content in bread.

Table 2: Effect of grape pomace powder incorporation on water absorption capacity, water solubility index, swelling power and bulk density of nutritious premix

Treatment	Water absorption capacity (g/g)	Water solubility index (%)	Swelling power (g/mL)	Bulk density (g/mL)
T_1: 70 g WF + 10 g BMF, CSF and 5 g DSF, OF	2.21 ^{f}	4.62 ^{a}	4.27 ^{f}	0.531 ^{a}
T_2: 65 g WF + 10 g BMF, CSF + 5 g DSF, OF and 5 g GPP	2.26 ^{e}	4.31 ^{b}	4.01 ^{a}	0.516 ^{b}
T_3: 60 g WF + 10 g BMF, CSF + 5 g DSF, OF and 10 g GPP	2.31 ^{d}	4.25 ^{c}	3.91 ^{b}	0.507 ^{c}
T_4: 55 g WF + 10 g BMF, CSF + 5 g DSF, OF and 15 g GPP	2.37 ^{c}	4.17 ^{d}	3.84 ^{c}	0.491 ^{d}
T_5: 50 g WF + 10 g BMF, CSF + 5 g DSF, OF and 20 g GPP	2.42 ^{b}	4.11 ^{e}	3.71 ^{d}	0.487 ^{d}
T_6: 45 g WF + 10 g BMF, CSF + 5 g DSF, OF and 25 g GPP	2.49 ^{a}	4.02 ^{f}	3.58 ^{e}	0.480 ^{e}
Mean	**2.34**	**5.89**	**3.66**	**0.502**
S.Em±	0.010	0.006	0.004	0.001
C.D at 1%	0.043	0.027	0.019	0.005

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour BMF: Barnyard millet flour CSF: Chia seed flour
DSF: Defatted soya flour OF: Oats flour GPP: Grape pomace powder

Table 3: Effect of treatments on colour (L^*, a^* and b^*) values of nutritious premix incorporated with grape pomace powder.

Treatment	*L**	*a**	*b**
T_1: 70 g WF + 10 g BMF, CSF and 5 g DSF, OF	53.04 ^{a}	2.54 ^{f}	7.41 ^{a}
T_2: 65 g WF + 10 g BMF, CSF + 5 g DSF, OF and 5 g GPP	49.32 ^{b}	3.44 ^{e}	5.02 ^{b}
T_3: 60 g WF + 10 g BMF, CSF + 5 g DSF, OF and 10 g GPP	47.15 ^{c}	3.63 ^{d}	4.54 ^{c}
T_4: 55 g WF + 10 g BMF, CSF + 5 g DSF, OF and 15 g GPP	45.24 ^{d}	3.78 ^{c}	4.04 ^{d}
T_5: 50 g WF + 10 g BMF, CSF + 5 g DSF, OF and 20 g GPP	43.28 ^{e}	3.88 ^{b}	3.84 ^{e}
T_6: 45 g WF + 10 g BMF, CSF + 5 g DSF, OF and 25 g GPP	41.61 ^{f}	4.02 ^{a}	3.25 ^{f}
Mean	**46.61**	**3.55**	**4.68**
S.Em±	0.130	0.009	0.035
C.D at 1%	0.532	0.039	0.146

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour BMF: Barnyard millet flour CSF: Chia seed flour
DSF: Defatted soya flour OF: Oats flour GPP: Grape pomace powder

Table 4: Effect of grape pomace powder incorporation on moisture, ash, protein, fat and fibre content of nutritious premix.

Treatment	Moisture (g/100g)	Ash (g/100g)	Protein (g/100g)	Fat (g/100g)	Fiber (g/100g)
T_1: 70 g WF + 10 g BMF, CSF and 5 g DSF, OF	9.01 ^{f}	2.11 ^{f}	14.09 ^{a}	2.831 ^{b}	13.12 ^{f}
T_2: 65 g WF + 10 g BMF, CSF + 5 g DSF, OF and 5 g GPP	9.35 ^{e}	2.52 ^{e}	13.94 ^{b}	2.872 ^{a}	14.68 ^{e}
T_3: 60 g WF + 10 g BMF, CSF + 5 g DSF, OF and 10 g GPP	9.40 ^{d}	2.54 ^{d}	13.72 ^{c}	2.876 ^{a}	15.02 ^{d}
T_4: 55 g WF + 10 g BMF, CSF + 5 g DSF, OF and 15 g GPP	9.45 ^{c}	2.56 ^{c}	13.56 ^{d}	2.881 ^{a}	15.42 ^{c}
T_5: 50 g WF + 10 g BMF, CSF + 5 g DSF, OF and 20 g GPP	9.53 ^{b}	2.59 ^{b}	13.31 ^{e}	2.887 ^{a}	15.92 ^{b}
T_6: 45 g WF + 10 g BMF, CSF + 5 g DSF, OF and 25 g GPP	9.58 ^{a}	2.61 ^{a}	13.01 ^{f}	2.894 ^{a}	16.42 ^{a}
Mean	**9.39**	**2.49**	**13.62**	**2.873**	**15.10**
S.Em±	0.007	0.004	0.007	0.002	0.005
C.D at 1%	0.032	0.018	0.028	0.008	0.023

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour BMF: Barnyard millet flour CSF: Chia seed flour
DSF: Defatted soya flour OF: Oats flour GPP: Grape pomace powder

Table 5: Effect of grape pomace powder incorporation on carbohydrate and energy value of nutritious premix

Treatment	Carbohydrate (g/100g)	Energy (kcal/100g)
T_1: 70 g WF + 10 g BMF, CSF and 5 g DSF, OF	59.93 [a]	316.90 [a]
T_2: 65 g WF + 10 g BMF, CSF + 5 g DSF, OF and 5 g GPP	56.62 [b]	308.10 [b]
T_3: 60 g WF + 10 g BMF, CSF + 5 g DSF, OF and 10 g GPP	56.42 [c]	306.48 [c]
T_4: 55 g WF + 10 g BMF, CSF + 5 g DSF, OF and 15 g GPP	56.11 [d]	304.62 [d]
T_5: 50 g WF + 10 g BMF, CSF + 5 g DSF, OF and 20 g GPP	55.75 [e]	302.24 [e]
T_6: 45 g WF + 10 g BMF, CSF + 5 g DSF, OF and 25 g GPP	55.46 [f]	299.96 [f]
Mean	**56.72**	**306.38**
S.Em±	0.012	0.074
C.D at 1%	0.052	0.306

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour BMF: Barnyard millet flour CSF: Chia seed flour
DSF: Defatted soya flour OF: Oats flour GPP: Grape pomace powder

Table 6: Effect of grape pomace powder incorporation on calcium, magnesium, iron and zinc content of nutritious premix

Treatment	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)
T_1: 70 g WF + 10 g BMF, CSF and 5 g DSF, OF	109.15 [f]	145.73 [f]	4.620 [b]	2.77 [d]
T_2: 65 g WF + 10 g BMF, CSF + 5 g DSF, OF and 5 g GPP	120.68 [e]	149.82 [e]	4.662 [a]	2.87 [c]
T_3: 60 g WF + 10 g BMF, CSF + 5 g DSF, OF and 10 g GPP	123.77 [d]	151.98 [d]	4.670 [a]	2.89 [c]
T_4: 55 g WF + 10 g BMF, CSF + 5 g DSF, OF and 15 g GPP	127.75 [c]	153.80 [c]	4.676 [a]	2.93 [b]
T_5: 50 g WF + 10 g BMF, CSF + 5 g DSF, OF and 20 g GPP	131.83 [b]	155.52 [b]	4.683 [a]	2.96 [ab]
T_6: 45 g WF + 10 g BMF, CSF + 5 g DSF, OF and 25 g GPP	136.77 [a]	157.49 [a]	4.691 [a]	2.98 [a]
Mean	**126.01**	**152.39**	**4.667**	**2.90**
S.Em±	0.155	0.194	0.003	0.006
C.D at 1%	0.639	0.795	0.016	0.027

Note: Mean values in the same column with different superscripts indicate a significant difference (p<0.01)
WF: Wheat flour BMF: Barnyard millet flour CSF: Chia seed flour
DSF: Defatted soya flour OF: Oats flour GPP: Grape pomace powder

Conclusion

From the present investigation, it can be concluded that the incorporation of grape pomace powder along with multigrains enhanced the nutritional quality of the formulated premix. The most suitable formulation was identified as treatment T_6 (T_6: 45 g WF + 10 g BMF, CSF + 5 g DSF, OF and 25 g GPP).

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