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Nutritional and Sensory Evaluation of Weaning Food Formulated with Mixed Fruits (Banana and Beetroot)

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Abstract

Malnutrition has a serious impact on the health of infants over the weaning period. Complementary foods that are nutritionally balanced should be given to ensure perfect growth and development. This study was meant to come up with both nutrient-enriched and taste-acceptable weaning foods using banana and beetroot due to their high nutritional content. Banana and beetroot were dried through a hybrid oven (60 °C) and a hot air oven (607 ^{0}C), respectively, and turned into powder. Six weaning food formulations were prepared using different proportions of whole wheat flour, banana powder, and beetroot powder (T-T6). They were researched on sensory properties, phytochemicals composition, and proximate composition. It has been noted that T6 contained the highest amounts of ash and fiber, and T1 contained the most amounts of fat, protein, and hydration. While T5 was the most sensory acceptable with a score of 8.3 due to its balanced banana content. Based on these findings, the nutritional value and attractiveness of weaning foods may be boosted by the incorporation of powdered banana and beetroot into the foods.

Keywords: Weaning Food, Nutrition, Banana, Beetroot, Infant

1. Introduction

Weaning is an important phase of infant development, as well as growth, the process that typically begins at the age of six months. The milk of the mother contains all the needed nutrients during the first half of the first year; however, over time, as a child grows, the milk ceases to satisfy their growing nutritional requirements (Morison et al., 2016). Therefore, in order to prevent malnutrition, encourage healthy growth, and develop appropriate feeding practices, complementary foods must be introduced on time (Shitemi et al., 2018).

Complementary foods should be soft, rich in nutrients, and easy to digest at this phase so that babies can progressively become accustomed to a range of flavors and textures. The World Health Organization states that in order to meet the changing nutritional demands of newborns, these foods must be safe, hygienic, and sufficient in calories, protein, as well as micronutrients (D'Auria et al., 2018). Stunting, developmental delays, and nutrient shortages have all been closely linked to inadequate or poorly designed weaning meals (Bhutta et al., 2013). For this reason, special care should be taken to create complementary foods that are simultaneously nutrient-dense as well as baby-friendly.

The best options for improving the nutritional value of weaning diets are fruits and vegetables. Their inherent abundance

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of vital minerals, vitamins, fiber, anti-oxidants, as well as phytochemicals, promotes metabolic health, immunity, and cognitive function (Slavin & Lloyd, 2012; Liu, 2013). Although these benefits exist, studies reveal that a considerable part of children who are 7 to 24 months old fail to consume proper quantities of vegetables and fruits (Grimm et al., 2014). Therefore, increasing their inclusion in supplemental foods may help address vitamin deficiencies and lower the chance of developing chronic illnesses in later life.

A popular food throughout infancy, bananas (*Musa paradisiaca*) are known for their favorable digestion, desirable flavor, as well as smooth texture. They are abundant in B-complex vitamins, calcium, phosphorus, and potassium, all of which are crucial for neurological and musculoskeletal development (Kabeer et al., 2023). Bananas have also shown promise for usage in processed foods, including flour, puree, alongside snacks, that can be added to a range of weaning food items.

Beetroot is an important for nutrition for babies (*Beta vulgaris L.*), a root vegetable in the Chenopodiaceae family. It contains high amounts of iron, vitamin C, flavonoids, carotenoids, and polyphenols that facilitate hemoglobin synthesis, enhance immunity, and have anti-inflammatory and antioxidant properties (Chhikara et al., 2019). Although taste preferences have limited its use in newborn feeds, beetroot's growing popularity in functional food items shows that it may be incorporated into weaning diets.

Considering how vital it is to address the deficiency of micro nutrients through broadened diets, the development of complementary foods employing ingredients that are accessible locally, like banana, beetroot, as well as flour made from whole wheat, can offer a practical solution. Therefore, the purpose of this study was to develop and assess the nutritional as well as sensory properties of weaning foods that contain powdered beetroot and banana. The goal is to create well-rounded, palatable, as well as reasonably priced formulations that can enhance the health of newborns and elevate the range of nutrient-dense products available on the market.

2. Materials and Methods

2.1.1 Raw materials

Whole wheat flour, banana, beetroot, and milk powder were procured from the local food market of Faisalabad, Pakistan. All the chemicals were of analytical grade.

2.1.2 Processing of raw material

Bananas at the third stage of ripeness and fresh beetroot were thoroughly washed, peeled, as well as sliced to an even thickness of 5 mm using a stainless-steel knife. To prevent enzymatic browning, the slices were first immersed in a 0.2% sodium metabisulfite solution. Like Bassey et al. (2013), bananas were dried in a hybrid oven set at 60°C for five hours. In line with Shilpa et al. (2023), beetroot slices were then dried utilizing a hot air oven set to 60–70°C for 7–10 hours. To guarantee consistent particle size, dried banana as well as beetroot were ground into fine powders separately and sieved over a 60–65 mesh screen. After manually cleaning the whole wheat grains to get rid of any foreign objects, they were rinsed under running water. Then soak for an 8-hour soak in water, the cleaned grains were then dried for 24 hours at 60°C using a hot air oven. In the next step, a grinder was used to ground the dry grains into fine flour according to Bekele and Shiferaw's (2020) methodology.

2.1.3 Product formulation

Six different concentrations of beetroot powder (BRP), banana powder (BP), and whole wheat flour (WWF) food premixes were developed. Chickpea flour served as a base ingredient in each formulation as shown in table 1. Furthermore, milk powder was added to each batch, then

Table 1 Product Formulation

Treatment	Whole wheat flour (%)	Banana powder (%)	Beetroot powder (%)
T1	90	10	-
T2	90	-	10
T3	80	20	-
T4	80	-	20
T5	80	10	10
T6	60	20	20

boiled until it was uniform, and then dried.

2.2. Chemical And Sensory Analysis

2.2.1 Proximate analysis

Utilizing standard methods established by the Association of Official Analytical Chemists (AOAC, 2016), the moisture, crude protein, crude fat, dietary fiber, as well as ash content of the weaning food premixes were evaluated.

2.2.2. Phytochemical analysis

A) Total phenolic content

Calculated as milligrams of gallic acid equivalents (GAE) per 100 grams employing the Folin–Ciocalteu technique as outlined by the American Academy of Nutrition and Acculturation (AOAC, 2016).

B) Total flavonoid content

Assessed in milligrams of quercetin equivalents (QE) per 100 grams and evaluated utilizing the aluminum chloride colorimetric approach in accordance with AOAC (2016) recommendations.

2.2.3. Sensory evaluation

Each weaning meal sample's sensory qualities (color, texture, taste, as well as general acceptability) were assessed by a trained panel of ten judges adopting a 9-point hedonic scale, where 9 represents extremely like and 1 represents extremely dislike. To prevent bias, samples were served in a randomized order under closely controlled settings.

2.2.4. Statistical analysis

Each investigation was performed three times. The mean ± standard deviation was utilized to express the data. A completely randomized design (CRD) was employed to apply one-way analysis of variance (ANOVA), and Tukey's test was applied to compare treatment means at a significance level of $p \leq 0.05$.

3. Results and Discussion

3.1. Proximate analysis

The proximate composition of the weaning food premixes is given in Table 2 and Figure 1. In T1, the moisture level was $7.38 \pm 0.04\%$, while in T6, it was $6.54 \pm 0.03\%$. As the concentration of both banana and beetroot powder increased, the moisture content decreased gradually, and the amount of whole wheat flour also declined in parallel. These results are related to an investigation by Martinez et al. (2015) that found that the fortification of more unripe banana flour to pasta recipes led to a decrease in moisture level of moisture. In a comparable manner, Pandey and Singh (2019) noted reduced moisture in weaning diets augmented with nuts as well as bananas. In T6, the crude protein level was $11.39 \pm 0.06\%$, down from $13.48 \pm 0.07\%$ in T1. These concentrations of beetroot and banana flour showed lower protein contents than whole wheat flour. Between T1 and T6, the premixes' fat levels varied from $3.97 \pm 0.02\%$ to $3.29 \pm 0.01\%$. %. In the paper of Khatun et al. (2013), where the fat contents were found to decrease, and weaning foods are produced using the germinated wheat and lentil flour, the fat level slightly decreases with the increase in the level of banana, as well as beetroot

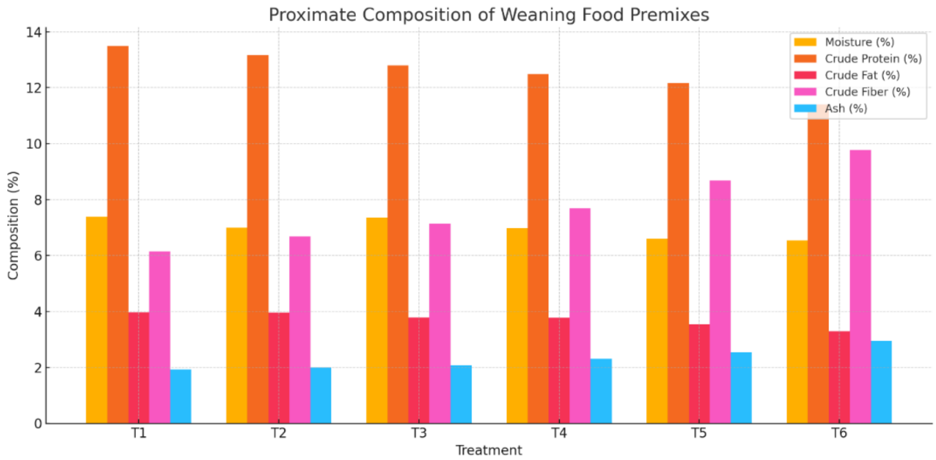

Figure 1 Proximate composition (%) of weaning food premix

powder. In the same case, addition of banana and pineapple pomace to legume-based weaning formulas was found to reduce the amount of fat (Mishra et al., 2014). Between T1 and T6, the crude fiber level rose substantially from 6.14 ± 0.03% to

9.77 ± 0.05%. By the addition of these two flours fiber content increased, but these findings observed less than the outcomes of Borbi et al. (2020), and found that the fiber level varied from 10.35% to 11.21%. Furthermore, the ash content also increased by 1.92 ± 0.01% (T1) to 2.96 ± 0.01% (T6), as observed that greater concentrations of powders, greater the mineral contents. Jahan et al. (2021) noticed that weaning diets made with mung bean and wheat flours had comparable ash levels. Overall, the addition of banana along with beetroot powders affected on the nutrients of formulations, with T1 had greater fat and protein ratios and T6 indicating greater fiber and mineral contents.

Table 2 Proximate analysis (%) of weaning premix

Treatment	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)
T-1	7.38±0.04^{a}	13.48±0.07^{b}	3.97±0.02^{b}	6.14±0.03^{b}	1.92±0.01^{b}
T-2	6.99±0.04^{a}	13.16±0.07^{c}	3.95±0.02^{b}	6.68±0.03^{c}	1.99±0.01^{c}
T-3	7.36±0.03^{b}	12.80±0.07^{d}	3.79±0.02^{c}	7.14±0.04^{d}	2.08±0.01^{d}
T-4	6.97±0.04^{b}	12.48±0.07^{e}	3.77±0.02^{c}	7.68±0.04^{e}	2.31±0.01^{e}
T-5	6.59±0.03^{c}	12.16±0.07^{f}	3.55±0.02^{d}	8.68±0.05^{f}	2.55±0.01^{f}
T-6	6.54±0.03^{c}	11.39±0.06^{g}	3.29±0.01^{e}	9.77±0.05^{g}	2.96±0.01^{g}

Means that carrying different letters is significantly different from each other (Tuckey's test, $p \leq 0.05$)
T_1=90%WWF+10%BP
T_2=90%WWF+10%BRP
T_3=80%WWF+20%BP
T_4=80%WWF+20%BRP
T_5=80%WWF+10%BP+10%BRP
T_6=60%WWF+20%BP+20%BRP

Table 3 Phytochemical composition of weaning food premix

Treatments	TPC (GAE mg/100g)	TFC (QE mg/100g)
T-1	9.78±0.05[a]	5.21±0.03[f]
T-2	11.24±0.06[b]	5.65± 0.03[d]
T-3	12.94±0.07[c]	5.84±0.03[e]
T-4	14.5± 0.08[d]	6.46±0.03[c]
T-5	15.3±0.08[e]	6.66±0.03[b]
T-6	16.7±0.09[f]	6.86±0.03[a]

Means that carrying different letters are significantly different from each other (Tuckey's test, $p \leq 0.05$)
T_1=90%WWF+10%BP
T_2=90%WWF+10%BRP
T_3=80%WWF+20%BP
T_4=80%WWF+20%BRP
T_5=80%WWF+10%BP+10%BRP
T_6=60%WWF+20%BP+20%BRP

3.2. Phytochemical analysis

The total amount of phenolic contents (TPC) and the total amount of flavonoid (TFC) of the weaning food formulations are below in Table 3. As the concentration rose gradually, a noticeable rise in TPC was shown. In T1, the TPC values were 9.78 ± 0.05 mg GAE/100g, while in T6, they were 16.7 ± 0.09 mg GAE/100g. The primary motivation of such an enhancement is an increased consumption of beetroot powder, which is a recognized provider of phenolic compounds with considerable antioxidant effects. These findings were consistent with the findings of Farhan et al. (2024), who observed that the level of phenolic compounds in sweets supplemented with beetroot powder was significantly higher. The total level of flavonoid also increased with every treatment, as it increased to 5.21mg QE/100g in T1 to 6.86mg QE/100g in T6. This trend has been contributed to by the inclusion of both beetroot and banana powders that contain natural flavonoids such as quercetin and catechins. The steady increase in TFC is attributed to the combined effects of the two fruit powders that enhanced the total functional properties, as well as to the antioxidant properties of the formulations. Chang et al. (2022) and Bana and Gupta (2015) have reported significant increases in TFC when using fruit powder in flour-based products based on the research using banana variants. In general, the phytochemical

Table 4 Sensory scores of weaning food premix

Treatment	Color	Texture	Taste	Overall acceptability
T-1	7.4±0.04[b]	7.1±0.03[b]	8.2±0.03[b]	8.0±0.04[cd]
T-2	7.6±0.04[c]	7.3±0.04[c]	7.9±0.04[c]	7.8±0.04[e]
T-3	8.0±0.04[d]	7.5±0.04[d]	7.8±0.04[c]	8.2±0.04[ab]
T-4	8.4±0.04[e]	7.7±0.04[e]	7.6±0.04[d]	7.9±0.04[de]
T-5	8.6±0.04[f]	8.1±0.04[f]	7.4±0.04[e]	8.3±0.04[a]
T-6	8.8±0.05[g]	8.3±0.04[g]	7.5±0.04[de]	8.1±0.04[bc]

Means that carrying different letters are significantly different from each other (Tuckey's test, $p \leq 0.05$)
T_1=90%WWF+10%BP
T_2=90%WWF+10%BRP
T_3=80%WWF+20%BP
T_4=80%WWF+20%BRP
T_5=80%WWF+10%BP+10%BRP
T_6=60%WWF+20%BP+20%BRP

analysis indicates that increasing concentrations of both banana and beetroot powders in the weaning food blends increase the overall antioxidant potential of these food products significantly, thereby increasing their health-promoting properties.

3.3. Sensory evaluation

The sensory assessment outcomes for color, texture, taste, as well as overall acceptability of the weaning food mixes are summarized in Table 4 and Figure 2. Under the 9-point hedonic scale, all samples scored within the appropriate sensory range, indicating broad consumer compatibility. From 7.4 ± 0.04 (T1) to 8.8 ± 0.05 (T6), the color scores varied. The score of T6 was much higher (p 0.05), possibly because the beetroot was deeper pigmented and gave it a desirable crimson color. These results are aligned with those of Chuwa et al. (2022), who concluded that the use of colored vegetables added to quick weaning mixtures increased the score on color. The texture score varied between 7.1⁻ 0.03 (T1) and 8.3 ± 0.04 (T6). The larger percentage of beetroot and banana most likely resulted in a less grainy and coherent texture, which enhanced the mouthfeel. Chuwa et al. (2022) proposed the same improvements to the texture of weaning products based on wheat, banana, and potatoes. The minimum and maximum of the scores on the taste scale were 7.4±0.04 (T5) and 8.4±0.04 (T1). Treatments of a bigger banana composition (T1 and T3) would frequently score more on taste tests since banana powder is naturally sweet. Conversely, the low taste rating of T6 could have been due to the earthy taste of the beetroot, which was not potent enough. T5 had the greatest overall acceptance score (8.3 ± 0.04), preceded by T3 and T6. T5's positive sensory perception in all of the assessed metrics might have been influenced by the appropriate incorporation of beetroot and banana (10% each). Chuwa et al. (2022), who found that composite weaning mixes with vegetable and fruit components had noticeably higher acceptability levels, corroborate their findings. In summary, all formulations were widely recognized among the sensory panel, with T5 indicating the most ideal blend of sensory attributes, rendering it an intriguing option for industrial weaning food development.

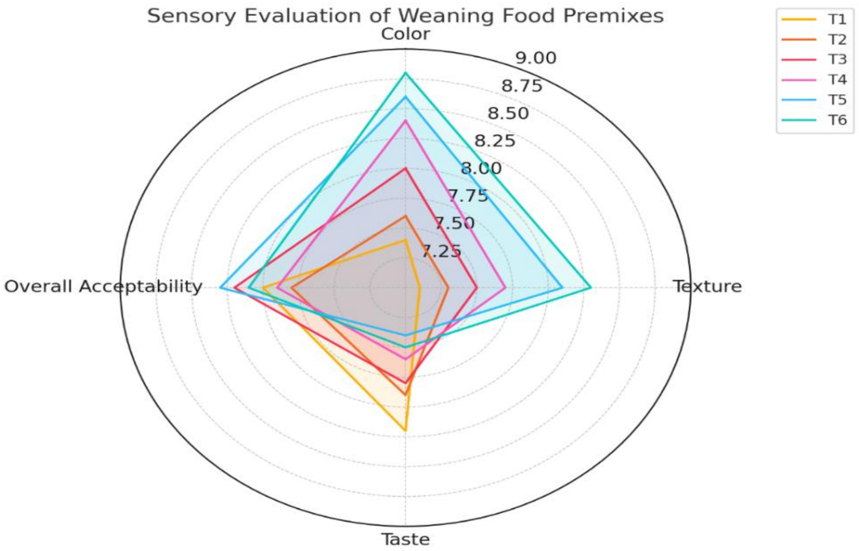

Figure 2 Graphical Representation of Sensory Evaluation

4. Conclusion

In order to enhance nutritional as well as sensory qualities, this study effectively developed and evaluated weaning meal premixes that included whole wheat flour, banana powder, along beetroot powder. The findings indicated that incorporating more banana and beetroot substantially raised the amount of dietary fiber, phenolic, as well as flavonoid content while lowering protein and fat levels very little. With equal amounts of beetroot and banana powders, T5 had the best overall sensory acceptance of any treatment, indicating that it has considerable potential for popularity among consumers. These results indicate the viability of using underused, locally accessible vegetable and fruit sources in the formulation of weaning foods to address baby nutritional shortcomings. In addition to adding functional value, the use of organic substances with antioxidant qualities complies with international guidelines for nutrient-dense, clean-label baby food. These formulations should be studied in the future to determine their therapeutic effects, shelf stability, and storage stability. A sustainable approach to addressing early childhood malnutrition may also be provided by including such goods in maternal-child health policy and community-level nutrition programs.

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