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CHEMICAL COMPOSITION, ORGANOLEPTIC PROPERTIES AND SAFETY EVALUATION OF STRATEGIC DIETARY PROTEIN JUICE PRODUCTS SUITABLE FOR SCHOOL CHILDREN

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ABSTRACT

Dietary Protein drink samples suitable for school children were formulated, produced and evaluated. Raw materials include; cashew, sweet orange, watermelon, carrot, tomato juices (rich in natural sugars and vitamins) and liquid soymilk (rich in protein and minerals). Seven (7) mixed juices, each contained combination of two fruit/vegetable juices, blended with liquid soymilk separately at five different ratios as % mixed juice ratio % soymilk (67:33,60:40, 50:50, 40:60 and 33:67), including control sample (exotic protein drink). All the experimental samples were subjected to sensory evaluation (colour, taste, flavour, mouth feel, consistency) and seven most promising samples, subsequently underwent chemical, microbiological and statistical data analyses. The sample protein contents include, 4.08% (mixed cashew + tomato, 60%/soymilk, 40%), 2.86% (mixed cashew + carrot, 50%/ soymilk, 50% and watermelon + tomato, 50%/soymilk, 50%), 2.33% (mixed orange + tomato, 55%/soymilk, 45%), while the rest samples and control had lower protein content value. Vitamin C, 91.7-41.2 mg/100ml (Cashew + tomato /soymilk, cashew + carrot/ soymilk and orange + tomato/soymilk), 20.0-27.5 mg/100ml for the rest and control. Beta carotene, 0.943-2.13 mg/100ml range, control has the lowest and minerals, k, Ca, Ma, Fe, Zn are present in all the samples. Energy/caloric values range from 1,423kj/l (cashew + carrot/soymilk) to 1,913kj/l (watermelon + carrot/soymilk). Sensory attributes of taste and flavour for cashew + tomato/soymilk, cashew + carrot/soymilk, watermelon+ tomato/soymilk samples were superior, as well as the colour of tomato + carrot/soymilk, watermelon + tomato/soymilk (bright/pale pink) over others, which were preferable to the control, and there was no significant difference ($p \leq 0.05$) among samples. Total plate counts in experimental samples ranged from $1.2x10^1$ – $2.2x\ 10^1$ cfu/ml, which fall within levels of acceptable limit for juices. Mould and coliform were not found, showing microbiological wholesomeness and safety. Combined nutrients composition and sensory attributes qualities have revealed samples, cashew +tomato (60%)/soymilk, (40%) and watermelon + tomato (50%)/ soymilk (50%) the best desirable protein drinks.

Keywords: Protein drink, fruit/vegetable juice, liquid soymilk, chemical analysis, sensory attributes, microbiological safety.

INTRODUCTION

Fruits and vegetables are rich natural sources of carbohydrates (soluble sugars), dietary fibre and vitamins (A, B, C, Folic), legumes/nuts good and cheap sources of vegetable protein/fat macronutrients and minerals such as Potassium, Calcium, Magnesium, Iron, Zinc (Orishagbemi 2016, Duckworth; 2006). These legumes, nuts, fruits and vegetables can be processed into primary products such as vegetable milk, fruit juices, pure, concentrate, which can be admixed into a single product to furnish essential food nutrients (protein, natural sugars, fibre, fat, vitamins, and minerals). Such mixture of liquid vegetable/animal milk and fruit/vegetable juices is known a protein juice or drink (Julie, 2004). If only one fruit/vegetable juice is mixed with milk, it is known as "fruit shake", such as banana, guava, pineapple, citrus shake (IFT, 2006). A typical protein juice or drink has been shown to be richer in food nutrients than ordinary milk and fruit juice when considered individually, and hence protein drink is suitable as functional product for school age children (3 – 10 years) especially for nutrition intervention programme. Ordinary milk whether vegetable or animal-based is richer in protein and low vitamins (for example, liquid soymilk has protein (4.15%), vitamins A & C (0.26 and 0.06mg/100g respectively), carbohydrates 8.8% and fruit juices richer in vitamins and soluble sugars, but poor protein contents, such as cashew apples having carbohydrates (17.5%), vitamin A (2500 I.U), vitamin C (360mg/100g), protein (0.6%), watermelon carbohydrate (16.7%), vitamin A (590 I.U), vitamin C (140mg/100g), protein (0.04%), sweet citrus carbohydrate (10.6%), vitamin A (350 I.U), vitamin C (88.1mg/100g), protein (0.8%), tomatoes carbohydrates (25.5%), vitamin A (1,499 I.U), vitamin C (22.9mg/100g), protein (2.4%), guava carbohydrates (14.8%), vitamin C (220mg/100g), protein (1.7%), mango carbohydrates (13.1%), vitamin C (50.37mg/100g), protein (0.78%), pawpaw carbohydrate (11.5%), vitamins A and C (9254 I.U and 141.9mg/100g respectively), protein (0.1%) (Orishagbemi,2016). In Nigeria, available records show that majority of school age children (3 – 10 years) both in public and private schools suffer malnutrition, especially deficiency syndromes of protein and essential micronutrients (vitamins A, B, C, Folic) and minerals (Fe, Ca, Mg, K, Zn, I_2) manifested as kwashiorkor, anaemia, scurvy, night blindness (WHO, 2009). Therefore, the objective of this work was to evaluate qualities of strategic protein juice samples produced, suitable for school children feedings (using citrus, cashew apple, watermelon, tomatoes, carrots and liquid soy milk) in terms of the sensory properties, nutrient contents and microbiological safety analysis.

MATERIALS AND METHODS

Raw materials and sources: Ripe and Fresh cashew apples, sweet oranges, watermelon (as fruits), Hausa tomatoes, carrots (as vegetables) and soy beans (as milk source) were obtained from Anyigba market, Kogi State, Nigeria.

Raw material/sample preparations and product formulations: standard procedures, equipment/instruments were used for the production of tomato, carrot, cashew apple, watermelon/orange juices and liquid soy milk as described (Orishagbemi, 2016, Duckworth, 2006, Iwe, 2003). Factorial experimental design involving seven (7) variables (mixed juices) was used to obtain protein drink formulations (Okporie, 2006).

Seven (7) mixed juices, each containing combination of two fruit/vegetable juices, blended with liquid soymilk separately at 5 different ratios, % mixed juice: % soymilk (67:33, 60:40, 50:50, 40:60 and 33:67 respectively), making 35 experimental samples and control. The mixed juices included watermelon/tomato, watermelon/ carrot, orange/tomato, orange/carrot, cashew/tomato, cashew/carrot and tomato/carrot. Each mixture contained equal proportion of fruit juice therein. The samples were produced, appropriately packaged (25 cL capacity bottle) and kept under refrigeration not longer than 4 weeks for product evaluation.

SENSORY EVALUATION AND ANALYTICAL METHODS

Sensory evaluation

The sensory attributes of taste, colour, flavour, mouthfeel and consistency of samples were evaluated based on 7 point hedonic scale rating (by factorial analysis) using 15 untrained panelists (pupils who can read and write) and standard procedures/data analysis (Iwe 2003, Okporie, 2006).

Chemical Composition Analysis

This involved proximate composition (moisture, protein, fat, ash, crude fibre, total carbohydrates), reducing sugars, vitamin contents (ascorbic acid as vitamin C, precursor, Beta carotene as vitamin A precursor), minerals (K, Fe, Zn, Ca, Mg) and energy/caloric values of top seven samples as revealed by sensory assessment, which were determined using standard methods and data analysis as described (Onwuka, 2005, Okporie, 2006, Pearson, 2011, Orishagbemi, 2011).

Ascorbic Acid Content Determination

Titration method as described by AOAC (2010) was used. Working standard solution of ascorbic acid was prepared (100mg ascorbic acid in 100 mL of 4% oxalic acid solution in 250 mL flask) and used. 5 mL working standard solution was pipetted into 100 mL flask, 10 mL of 4% oxalic acid added and then titrated against dye solution (V_1 mL) containing 2, 6 – dichlorophenol – indophenol which oxidized ascorbic acid. Pink colour appearance marked end point. Quantity of dye consumed is equivalent to the amount of ascorbic acid. Protein juice sample (5 mL) was extracted with 100mL of 4% oxalic acid using separating funnel, then centrifuged (100rpm). Then 5mL of supernatant pipetted, 10mL 4% oxalic acid added and then titrated against dye solution to obtain (V_2 mL).

Ascorbic acid (mg/100g mL)

$$= \frac{0.5\text{mg}}{V_1\text{mL}} \times \frac{V_2}{5\text{mL}} \times \frac{100\text{ mL}}{5\text{mL sample}} \times 100$$

Triplicate determinations were made and average recorded.

Beta carotene (vitamin precursor) content determination

The method described (AOAC, 2004) was used to determine beta carotene content. Five gram (5g) juice was extracted with 40mL hexane, 60mL ethanol mixture. The mixture then transferred to a separating funnel and swung vigorously; after adding 20mL of 20% sodium chloride solution. The mixture was allowed to settle, then lower layer was run off. The top layer hexane containing carotenoids was collected, diluted and the optical density measured using spectronic 20 at 440nm wavelength. 3 determinations were made for each sample and average value recorded.

Mineral contents determination

Atomic absorption spectrophotometer (Model Pu 91003, England) was used to determine Mg, Ca, Zn, Fe contents as described (Ibitoye, 2005, Onwuka, 2005). 1.0g of protein drink sample was weighed and first digested with 20mL of acid mixtures (650mL Conc. HN_{O3}, 80mL Perchloric acid, 20mL Conc. $H_2S_{O}4$) to obtain clear digest, which was made up to 100mL with distilled water. This was used for atomic absorption spectrophotometry using individual lamps and wavelength for each element (as specified on the instruction manual). Calibration curves were prepared for each element using standard solutions, then concentration of element was determined using the calibration curve by interpolation.

ENERGY (CALORIC) VALUE DETERMINATION

Energy/caloric value of protein drink samples were determined using Atwater factor method (Onigbinde, 2005). The amounts of protein, carbohydrates and fats contents (g/L) in the samples, based on the proximate composition, were used for calculations each gram of carbohydrate and protein furnishes 16.8KJ and fat, 37.8KJ energy).

SAFETY EVALUATION

This involved microbiological safety analysis which include determination of total plate counts, TPC (cfu/mL), mould (MPN/mL) and coliform (MPN/mL) of protein drink samples using standard culture media and procedures as described (Ogbo, 2005 and Adegoke, 2004), in order to ascertain microbiological wholesomeness and safety of the samples for consumption.

Statistical data analysis

Data obtained were subjected to one way analysis of variance (ANOVA). Tukey's test was used to separate means where significantly different, $p \leq 0.05$ (Iwe, 2003).

RESULTS AND DISCUSSION

Sensory attributes of dietary protein drink samples.

The mean sensory attribute scores of experimental protein juices are shown in tables 1 – 7.

Taste: Sample of mixed cashew + tomato/soymilk (60%/40% ratio respectively) was rated highest (6.9-

score), followed by mixed cashew + carrot/soymilk (50/50); watermelon + tomato/soymilk (50/50), orange + tomato/soymilk (55/45) and the least being mixed tomato + carrot/soymilk (50/50). Apparently, taste of all experimental samples were preferable to the control, and there was no significant different ($p \leq 0.05$) amount samples. The superior taste of cashew, tomato and soymilk mixed drink is due to very high reducing/soluble sugars content; even it is the highest among other samples as revealed by chemical analysis, and similar to research report of direct relationship between taste/sweetness and sugar content of food drinks/juices.

Colour: Tomato + carrot/soymilk (50/50) sample had the highest score (7.00 mean) with bright pink, followed by watermelon + carrot/soymilk (50%/50%) with light pink colour, orange + carrot/soymilk (60%/40%), pale pink, cashew + carrot/soymilk (50%/50%), while orange + tomato/soymilk (55%/45%) the least desirable with pale brown. There seemed to be significant difference ($p \leq 0.05$) in colour among the samples. Colour is attributed to natural pigment of component juices, which depended on the dominant type, carrot (pinkish yellow), tomato (purple-red), watermelon (pinkish-red), soymilk (dull white)

Flavour: The cashew + carrot, watermelon + tomato, cashew + tomato-based protein drinks had superior flavour (mean score range, 6.5 – 7.00) over orange + tomato, watermelon + carrot-based samples. However, all the experimental protein drink samples had flavour preferred to the control with least mean score (5.80). Variation in flavour of samples is majorly as result of various volatile aromatic compounds present which is characteristic of each fruit/vegetable commodity and also extent or degree of ripeness of such fruit.

Mouthfeel and consistency: The experimental protein drink samples showed similar mouthfeel, regardless of the mixture components. The mouthfeel mean scores ranged from 5.8 (tomato + carrot/soymilk, 50%/50%) to 6.7 (cashew + tomato/soymilk, 60%/40%) without any detectable significant difference ($p \leq 0.05$). Consistency also followed similar trend as mouthfeel, mean score ranged from 6.5 – 6.9. Similarity is attributable to the same granularity of samples, with slight variation in viscosity as reported in a previous work by the researchers (Orishagbemi *et al.,* 2015). Based on the sensory attributes of experimental samples, especially taste and colour, seven samples with codes, AAA (mixed cashew + tomato/soymilk, 60%/40%), BBB (mixed cashew + carrot/soymilk, 50%/50%), CCC (mixed watermelon + tomato/soymilk, 50%/50%), DDD (watermelon and carrot/soymilk, 50%/50%), EEE (orange + tomato/soymilk, 55%/45%), FFF (orange + carrot/soymilk, 60%/40%) and GGG (tomato + carrot/soymilk, 50%/50%) are promising desirable protein drinks and they were selected for chemical analysis, since protein, vitamin and mineral contents are other vital quality attributes required of typical protein drink for school children.

Chemical composition (proximate composition, vitamin and mineral contents) of dietary protein drink samples.

Table 8 shows the proximate composition, vitamin and mineral contents of experimental protein drink samples. All the protein drink samples showed high moisture content including the control (88.3-92.14%, dry basis), this is expected because natural fruit juices have characteristic high moisture levels. The protein contents of samples ranged from 1.80% (sample DDD, mixed watermelon + carrot/soy (50%) to 4.08% (sample AAA, mixed cashew + tomato/soymilk, 60% /40%), where samples AAA, BBB (mixed cashew + carrot/soy, 50%/50%), CCC (mixed watermelon + tomato/soymilk 50%/50%) and EEE (mixed orange + tomato/soymilk, 55%/45%) have higher protein contents values than control, HHH- imported protein juice (2.25%). Therefore, any of these samples is suitable as protein drink depending on desirable sensory attributes. Cashew, tomato and carrot based samples seemed to have higher protein contents than other protein drink, because the raw vegetable juice components have been reported to contain minute protein in greater quantity than other fruit juices (Duckworth, 2006). Ash contents (0.12-0.64% range, highest in sample AAA), fat (0.66 – 1.74% range, highest in control sample), and crude fibre (0.0006 – 0.003%, highest in sample AAA) are generally low in all the protein drink samples, which is characteristic of natural juice. However, low fat content would not support rancidity spoilage of protein drink. Carbohydrate contents are higher (7.18-7.69%) in samples AAA (mixed watermelon + carrot /soymilk, 50%/50%), FFF (mixed orange + carrot/soymilk, 60% /40%) and HHH control than others (3.02 - 5.5%) including AAA, BBB, CCC and GGG samples. The carbohydrate constituents are mainly simple reducing sugars (520-766 mg/100ml range) necessary for energy supply. High carbohydrate contents in watermelon and sweet orange – based protein drinks is attributable to higher natural sugar contents (7.5-8.2%) than in cashew, tomato and carrots (4.7-5.15%) as reported in previous work of the researchers (Orishagbemi, *et. al;* 2015). The energy value per litre of experimental protein juice ranged from 1,423.0KJ (sample BBB, mixed cashew +carrot /soymilk, 50%/50%) to 1,913.8KJ (sample DDD, watermelon + carrot/soymilk, 50%/50%) which varied with the sugar/carbohydrate and protein contents. This is also adequate to meet energy need of a school pupil (3 – 10 years) per day on consumption of half litre drink (WHO 2009). Ascorbic acid content is quite high in samples AAA (cashew/tomato/soymilk) and BBB (cashew/carrot/soymilk) with the respective values of 91.13 and 73.36mg/100ml, and low in others, including the control, HHH (27.52mg/100ml). Samples GGG (tomato/carrot/soymilk), EEE (orange / tomato/soymilk), CCC (watermelon / tomato/soymilk), AAA (cashew / tomato/soymilk), BBB (cashew/carrot/soymilk) and HHH (control) are richer in B-carotene (0.934-2.12mg/100ml) than DDD (watermelon / carrot/soymilk)and FFF(orange / carrot/soymilk). Availability of both ascorbic acid (vitamin C processor) and Beta carotene (vitamin A precursor) in protein drink would serve to prevent scurvy and night blindness in regular consumers, especially school children. All the experimental protein drink samples are high in potassium (241-207mg/l) especially samples EEE, FFF and AAA. Calcium, 11.9-23.50mg/100ml (samples FFF, DDD, EEE and HHH), but low in Zinc (0.6-1.59mg/100ml), magnesium (1.67-1.76mg/100ml) and iron (0.97-1.92mg/100ml). Based on the aggregate nutrient composition (protein, reducing sugars, vitamin and minerals-k, Ca, Zn, Mg, Fe) samples AAA (cashew / tomato/soymilk), BBB (cashew / carrot/soymilk), CCC (watermelon / tomato/soymilk) EEE (orange / tomato/soymilk) and GGG (tomato / carrot/soymilk) are more suitable than the control (imported brand) as protein drinks for school children.

Microbiological contents /analysis of protein drink samples

The microbiological contents of experimental protein juice and control samples are shown in table 9. Total plate counts found in samples AAA, mixed cashew / tomato/soymilk ($2x10^1$ cfu/ml), BBB, mixed cashew / carrot/soymilk ($1.5x10^1$ cfu/ml), CCC, mixed watermelon / tomato/ soymilk ($2x10^1$ cfu/ml), DDD, watermelon / carrot /soymilk ($2.0x10^1$cfu/ml), EEE, orange / tomato/soymilk ($1.2x10^1$cfu/ml), FFF, mixed orange / carrot/soymilk ($2.1x10^1$), GGG, mixed tomato/ carrot/soymilk ($2.2x10^1$ cfu/ml), and HHH, control sample (1.6×10^1 cfu/ml). The samples were merely pasteurized and not given commercial sterilization, which allowed traces of inactivated bacteria still found, but quantitative values are within level of acceptable limits for juices (NIS, 2010). Bacterial cells found are natural microflora of the respective raw commodities used, rather than pathogenic types. Moulds and colifom were absent in all the samples, including the control. This is an indication of strict adherence to hygienic and good manufacturing practices/procedures, and also showed the use of clean water without any faecal contamination. Hence, the protein juice drink samples are adjudged to be microbiologically wholesome and safe for human consumption. However, storage evaluation/shelf life study is not considered, but in another work.

CONCLUSION

Seven (7) organoleptically desirable dietary protein drink samples out of thirty-five produced were investigated for chemical, microbiological analysis and sensory properties to determine the most suitable for school children. Samples found to be of high qualities (in terms of nutrients content, sensory attributes, microbiological safety) include; mixed cashew, tomato/soymilk, 60%/40% (sample AAA), mixed cashew, carrot/soymilk, 50%/50% (sample BBB), mixed watermelon, carrot/soymilk, 50%/50% (sample CCC), orange, tomato /soymilk, 55%/45% (sample EEE) and mixed tomato, carrot/soymilk, 50%/50% (sample GGG). They are richer than exotic protein drink (control) in protein and micro nutrients, and therefore any of the samples is adjudged suitable for school children to improve nutrition.

Table 1: Mean sensory scores of protein drink from blends of watermelon/carrot mixed juice/soymilk

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	5.44 ± 0.11^{ef}	5.73 ± 0.01^{c}	5.73 ± 0.12^{d}	5.83 ± 0.10^{b}	6.50 ± 0.03^{a}
60:40	5.57 ± 0.08^{e}	5.80 ± 0.10^{c}	5.81 ± 0.05^{d}	6.35 ± 0.06^{a}	6.50 ± 0.10^{a}
50:50	5.89 ± 0.01^{e}	5.67 ± 0.03^{c}	5.66 ± 0.03^{d}	6.60 ± 0.04^{a}	6.61 ± 0.02^{a}
40:60	5.70 ± 0.10^{ef}	5.56 ± 0.11^{c}	5.54 ± 0.10^{d}	5.84 ± 0.01^{b}	5.85 ± 0.01^{ab}
33:67	5.45 ± 0.00^{ef}	5.60 ± 0.05^{c}	5.65 ± 0.02^{d}	5.80 ± 0.01^{b}	5.671 ± 0.04^{ab}
CTL (control)	5.41 ± 0.02^{ef}	5.58 ± 0.00^{c}	5.79 ± 0.01^{d}	5.39 ± 0.02^{b}	4.56 ± 0.10^{b}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p\leq 0.05$).

Table 2: Mean sensory scores of protein drink from blends of watermelon/ tomato mixed juice/soymilk

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	6.10 ± 0.02^{ef}	6.50 ± 0.01^{g}	6.70 ± 0.15^{b}	6.35 ± 0.11^{p}	6.81 ± 0.08^{n}
60:40	6.13 ± 0.83^{e}	6.53 ± 0.30^{g}	6.80 ± 0.32^{b}	6.33 ± 1.12^{p}	6.66 ± 0.34^{n}
50:50	6.72 ± 0.21^{a}	6.65 ± 0.10^{g}	6.85 ± 0.12^{b}	6.65 ± 0.13^{p}	6.75 ± 0.06^{n}
40:60	6.35 ± 0.11^{a}	6.18 ± 0.12^{g}	6.51 ± 0.03^{b}	$6.28\pm.012^{p}$	26.80 ± 0.12^{n}
33:67	6.28 ± 0.04^{a}	5.88 ± 0.07^{e}	6.55 ± 0.01^{b}	5.85 ± 0.10^{op}	6.25 ± 0.09^{n}
CTL (control)	5.78 ± 0.13^{c}	6.23 ± 0.22^{g}	5.49 ± 0.72^{c}	6.06 ± 0.54^{op}	4.56 ± 0.08^{m}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p\leq 0.05$).

Table 3: Mean sensory scores of protein drink from blends of orange/carrot mixed juices and soymilk

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	6.35 ± 0.01^{m}	6.60 ± 0.04^{j}	6.55 ± 0.10^{a}	5.85 ± 0.02^{c}	6.5 ± 0.00^{b}
60:40	6.7 ± 0.03^{m}	6.8 ± 0.07^{j}	6.65 ± 0.10^{a}	6.75 ± 0.03^{c}	6.9 ± 0.01^{b}
50:50	6.8 ± 0.11^{m}	6.75 ± 0.08^{j}	6.8 ± 0.13^{a}	6.60 ± 0.10^{c}	6.8 ± 0.08^{b}
40:60	5.75 ± 0.06^{n}	6.21 ± 0.04^{k}	6.15 ± 0.10^{a}	5.6 ± 0.01^{d}	6.7 ± 0.03^{b}
33:67	5.68 ± 0.01^{n}	5.74 ± 0.03^{k}	6.25 ± 0.01^{a}	5.5 ± 0.10^{d}	6.8 ± 0.05^{b}
CTL (control)	5.78 ± 0.11^{n}	6.12 ± 0.06^{k}	5.98 ± 0.12^{a}	6.30 ± 0.04^{c}	6.40 ± 0.02^{b}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p\leq 0.05$).

Table 4: Mean sensory scores of protein drink from blends of orange/ tomato mixed juices and soymilk

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	6.40 ± 0.03^{qr}	6.25 ± 0.02^{r}	6.5 ± 0.01^{a}	6.45 ± 0.01^{b}	6.40 ± 0.10^{c}

60:40	5.85±0.01^{q}	6.90±0.11^{r}	6.7±0.05^{a}	6.25±0.05^{b}	6.50±0.01^{c}
50:50	6.15±0.00^{q}	6.85±0.01^{r}	6.8±0.11^{a}	6.25±0.00^{b}	6.65±0.04^{c}
40:60	5.75±0.01^{q}	5.8±0.10^{s}	6.6±0.08^{a}	6.55±0.11^{b}	6.55±0.10^{c}
33:67	5.60±0.06^{q}	5.75±0.11^{s}	6.20±0.01^{a}	6.50±0.06^{b}	6.58±0.03^{c}
CTL (control)	5.78±0.10^{q}	6.20±0.05^{r}	6.10±0.08^{a}	6.40±0.11^{b}	6.40±0.10^{c}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p \leq 0.05$).

Table 5: Mean sensory scores of protein drink (cashew/tomato and soymilk)

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	6.5±0.11^{b}	6.1±0.02^{ab}	6.7±0.01^{d}	6.85±0.03^{f}	6.2±0.01^{e}
60:40	6.8±0.07^{b}	7.0±0.01^{a}	6.8±0.03^{d}	6.70±0.01^{f}	6.25±0.02^{e}
50:50	6.75±0.02^{b}	6.9±0.00^{a}	6.7±0.00^{d}	6.75±0.11^{f}	6.30±0.03^{e}
40:60	6.70±0.10^{b}	5.9±0.03^{ab}	6.30±0.10^{dc}	6.5±0.06^{f}	6.1±0.11^{e}
33:67	6.5±0.11^{b}	5.7±0.10^{ab}	6.25±0.06^{dc}	6.5±0.01^{f}	5.9±0.04^{e}
CTL (control)	5.7±0.13^{ab}	6.1±0.13^{ab}	5.8±0.09^{dc}	6.4±0.00^{f}	6.30±0.06^{e}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p \leq 0.05$).

Table 6: Mean sensory scores of protein drink (cashew/carrot and soymilk)

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	6.7±0.11^{a}	6.75±0.02^{c}	6.80±0.04^{f}	6.7±0.08^{d}	6.2±0.01^{b}
60:40	6.8±0.08^{a}	6.70±0.00^{c}	7.0±0.01^{f}	6.8±0.03^{d}	6.60±0.05^{b}
50:50	6.0±0.03^{a}	6.9±0.03^{b}	7.0±0.03^{f}	6.8±0.05^{d}	6.65±0.02^{b}
40:60	6.7±0.10^{a}	6.65±0.01^{c}	6.4±0.00^{e}	6.3±0.10^{d}	5.9±0.01^{c}
33:67	6.2±0.05^{a}	6.40±0.01^{c}	5.7±0.05^{e}	6.4±0.00^{d}	5.8±0.00^{c}
CTL (control)	5.75±0.00^{ab}	6.2±0.12^{c}	5.8±0.01^{e}	6.40±0.00^{d}	6.35±0.02^{b}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p \leq 0.05$).

Table 7: Mean sensory scores of protein drink (tomato/carrot and soymilk)

Sample	Sensory Attributes				
Mixed Juice: S/Milk	Colour	Taste	Flavour	Mouthfeel	Consistency
67:33	6.5 ± 0.13^{ab}	5.6 ± 0.02^{d}	6.85 ± 0.11^{ef}	6.10 ± 0.10^{mn}	6.7 ± 0.11^{h}
60:40	6.8 ± 0.07^{a}	6.1 ± 0.01^{d}	6.7 ± 0.10^{ef}	6.00 ± 0.02^{n}	6.7 ± 0.06^{h}
50:50	7.0 ± 0.11^{a}	6.2 ± 0.05^{d}	6.7 ± 0.11^{ef}	5.80 ± 0.01^{n}	6.80 ± 0.15^{h}
40:60	6.7 ± 0.10^{ab}	5.5 ± 0.01^{dc}	6.2 ± 0.05^{f}	5.60 ± 0.01^{n}	6.7 ± 0.03^{h}
33:67	6.7 ± 0.08^{ab}	5.4 ± 0.10^{dc}	6.15 ± 0.03^{f}	5.5 ± 0.11^{n}	6.9 ± 0.10^{h}
CTL (control)	5.7 ± 0.02^{c}	6.0 ± 0.04^{d}	5.8 ± 0.10^{f}	6.4 ± 0.03^{mn}	6.5 ± 0.15^{h}

Values represent mean scores of 15 panelists ± SD (standard deviation).
Values in a column with the same superscript are not significantly different ($p \leq 0.05$).

Table 8: Proximate composition, vitamin and mineral contents of fresh protein juice samples (Top 7 samples and control)

Samples

Analytical parameter	AAA	BBB	CCC	DDD	EEE	FFF	GGG	HHH
Moisture content (%)	90.54 ± 1.02	90.29 ± 0.91	92.14 ± 0.35	91.48 ± 0.55	91.21 ± 1.01	91.08 ± 0.93	92.15 ± 0.86	88.34 ± 0.71
Ash (%)	0.64 ± 0.22^{ab}	0.45 ± 0.10^{ab}	0.31 ± 0.01^{b}	0.12 ± 0.23^{c}	0.30 ± 0.14^{b}	0.32 ± 0.03^{b}	0.32 ± 0.03^{b}	0.33 ± 0.02^{b}
Protein content (%)	4.08 ± 0.11^{b}	2.96 ± 0.10^{a}	2.96 ± 0.11^{a}	1.80 ± 0.02^{d}	2.33 ± 0.01^{c}	1.88 ± 0.12^{d}	2.04 ± 0.21^{c}	2.25 ± 0.22^{c}
Fat (%)	0.71 ± 0.00^{bc}	0.66 ± 0.02^{bc}	1.16 ± 0.11^{e}	0.83 ± 0.04^{b}	0.77 ± 0.03^{bc}	0.53 ± 0.11^{c}	1.53 ± 0.13^{e}	1.74 ± 0.11^{e}
Crude fibre (%)	0.0030 ± 0.01^{d}	0.0005 ± 0.01^{c}	0.0020 ± 0.02^{d}	0.0006 ± 0.01^{c}	0.0010 ± 0.01^{dc}	0.0020 ± 0.01^{d}	0.0010 ± 0.01^{dc}	0.0020 ± 0.01^{d}
Carbohydrates (%)	3.027 ± 0.11^{e}	4.090 ± 0.11^{e}	3.428 ± 0.09^{e}	7.69 ± 0.10^{f}	5.519 ± 0.21^{ef}	7.188 ± 0.05^{f}	3.959 ± 0.23^{e}	7.338 ± 0.26^{f}
Reducing sugars (mg/100mL)	766 ± 3.12^{a}	510 ± 4.08^{ab}	740 ± 1.67^{a}	520 ± 2.89^{ab}	702 ± 8.11^{a}	620 ± 5.68^{a}	425 ± 3.01^{c}	625 ± 20.13^{a}
Ascorbic acid (mg/100mL)	91.73 ± 0.81^{b}	73.36 ± 0.52^{b}	25.22 ± 0.33^{a}	20.64 ± 0.31^{d}	$41.28\pm.028^{bd}$	24.77 ± 0.23^{d}	18.35 ± 0.17^{d}	27.52 ± 0.31^{c}
Vitamins A (As β-carotene mg/100mL)	0.943 ± 0.14^{f}	0.943 ± 0.13^{f}	1.301 ± 0.11^{h}	0.886 ± 0.11^{f}	1.018 ± 0.08^{h}	0.887 ± 0.07^{f}	2.122 ± 0.12^{g}	1.037 ± 0.06^{h}
Folic acid (mg/100mL)	13.40 ± 0.21	13.34 ± 0.18	12.92 ± 0.11	13.36 ± 0.16	13.40 ± 0.20	12.98 ± 0.17	13.34 ± 0.21	13.30 ± 0.21
Potassium (mg/100mL)	207.52 ± 2.22^{cf}	193.55 ± 2.1^{c}	205.37 ± 2.5^{cf}	190.32 ± 1.0^{c}	241.93 ± 1.8^{cf}	210.75 ± 1.2^{cf}	192.47 ± 0.91^{c}	181.72 ± 0.85^{c}
Iron (mg/100mL)	8.025 ± 0.23^{k}	1.338 ± 0.05^{e}	1.814 ± 0.14^{kc}	1.354 ± 0.14^{e}	1.669 ± 0.25^{e}	0.976 ± 0.06^{ke}	1.604 ± 0.07^{e}	1.929 ± 0.55^{kc}
Zinc (mg/100mL)	1.57 ± 0.01^{c}	1.30 ± 0.01^{c}	1.24 ± 0.05^{cd}	1.14 ± 0.02^{rc}	1.56 ± 0.04^{c}	0.62 ± 0.01^{r}	1.29 ± 0.03^{cd}	1.32 ± 0.11^{c}
Calcium (mg/100mL)	4.36 ± 0.11^{b}	5.40 ± 0.13^{b}	4.97 ± 0.28^{b}	12.15 ± 0.55^{bt}	12.10 ± 0.48^{bt}	23.50 ± 0.67^{t}	9.30 ± 0.24^{bt}	11.94 ± 0.33^{bt}

Magnesium (mg/100mL)	1.674±0.11	1.756±0.08	1.749±0.06	1.763±0.04	1.725±0.38	1.753±0.29	1.692±0.36	1.735±0.27
Energy (kJ/L)	1450.7±5.1	1.423.0±4.6	1,489.1±4.9	1,913.8±5.6	1,606.4±6.0	1,737.6±4.8	1,586.1±3.9	2,274.1±6.8

Values represent mean (n=3) determinations ±SD (Standard Deviation). Means in a row with the same superscript are not significantly different ($p \leq 0.5$)

Sample Codes:

AAA Mixed cashew/Tomato (60): Soymilk (40)
BBB Mixed cashew/carrot (50): Soymilk (50)
CCC Watermelon./Tomato (50): Soymilk (50)
DDD Watermelon/Carrot (50): Soymilk (50)
EEE Orange/Tomato (55): Soymilk (45)
FFF Orange/Carrot (60): Soymilk (40)
GGG Tomato/Carrot (50): Soymilk (50)
HHH Imported Protein Juice (Control)

Table 9: Microbiological contents of fresh protein drink samples

Microbiological parameter	Samples AAA	BBB	CCC	DDD	EEE	FFF	GGG	HHH
TPC (cfu/mL)	2×10^{1}	1.5×10^{1}	2×10^{1}	2.1×10^{1}	1.2×10^{1}	1.5×10^{1}	2.1×10^{1}	1.5×10^{1}
Mould (MPN/mL)	–	–	–	–	–	–	–	–
Coliform (MPN/mL)	–	–	–	–	–	–	–	–

Values represent means n = 2, ±S.D. (Standard Deviation)

Sample Codes:

Sample Codes:

AAA Mixed cashew/Tomato (60): Soymilk (40)
BBB Mixed cashew/carrot (50): Soymilk (50)
CCC Watermelon/Tomato (50): Soymilk (50)
DDD Watermelon/Carrot (50): Soymilk (50)
EEE Orange/Tomato (55): Soymilk (45)
FFF Orange/Carrot (60): Soymilk (40)
GGG Tomato/Carrot (50): Soymilk (50)
HHH Imported Protein Juice (Control)
TPC Total Plate Counts
MPN Most Probable Number

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