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FORMULATION AND CHARACTERIZATION OF NUTRACEUTICAL NECTAR BASED ON ORANGE JUICE AND GREEN TEA

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ABSTRACT: Green tea represents a popular beverage worldwide due to its high polyphenol and antioxidant activity. It is commonly brewed along with vitamin C source which plays a positive role in maintaining its antioxidant potential. Orange juice can serve as an excellent medium for supplementation of green tea for the formulation of nutraceutical nectar by enriching drink with vitamin C and overcoming the astringent taste of tea. Therefore, the present study was planned to develop nutraceutical nectar by blending green tea with orange juice at 60, 50, 40 and 30% levels while orange juice and green tea served as control. The formulations were analyzed for their sensory as well as nutritional properties. Among all the samples, the highest values for ash content, ascorbic acid content, titratable acidity, and TSS were recorded for orange juice. Green tea displayed the highest values for total flavonoid content, antioxidant activity (FRAP, DPPH, TEAC), moisture content and pH compared to other blends. Blending green tea with an increasing concentration of orange juice resulted in a reduction in flavonoid content and antioxidant activity while ascorbic acid and ash content increased in the blends. Color and titratable acidity improved with the corresponding increase in orange juice levels. It was concluded by the overall sensory and nutritional properties that the formulation containing an equal proportion of green tea and orange juice was most acceptable.

INTRODUCTION: Over the past decade, consumers have become more aware of healthier eating habits, which have been paralleled by a considerable increase in the commercialization of natural and organic foods based on fruit and vegetables. Many epidemiological studies suggest that consumption of fruits and vegetables is beneficial to health and contributes to the prevention of degenerative processes, particularly lowering incidence and mortality rate of cancer and cardio- and cerebrovascular diseases^{1, 2, 3}.

The protective effect conferred by fruits and vegetables to various diseases has been ascribed to the antioxidant and polyphenolic compounds present in them^{4, 5, 6, 7}. Among the different fruit and vegetable-based products, beverages from fruits and vegetables are popular across the population of all the age groups as they constitute delicious and refreshing drinks besides playing an important role in human nutrition. Depending on the content of fruit pulp or juice in the final product, beverages can be divided into juice, nectar, squash and ready to serve drinks.

According to Food Safety and Standards Authority of India (FSSAI), industrially produced juice is a drink that is obtained either directly from the fruit or reconstituted from concentrated juice until the soluble solids contents of the whole original juice are reached⁸.

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On the other hand, the nectar is a drink prepared from concentrated juice that may be diluted with water and contain additives like sweeteners and preservatives. The minimum level of concentrated juice in most of the nectars is 25% (m/v) while in case of minimum orange fruit content is 40% (m/v). Fruit juice nectar, in particular orange juice nectar is an appropriate medium for the fortification of nutraceutical components due to its good sensorial attributes and remarkable nutrient profile consisting of antioxidant compounds such as ascorbic acid, vitamin E, beta-carotene, and phenolic compounds that are able to inactivate free radicals^{9, 10, 11, 12, 13}.

Orange, botanically known as *Citrus sinensis*, belongs to the family Rutaceae and is one of the most commonly grown fruit crop. Oranges are known to be a good quiet source of vitamin C which varies from 150 to 450 mg/l, and about one glass has been studied sufficiently to meet about 30-80% of recommended daily intake of vitamin C of 100-120 mg/day¹⁴. Oranges are also a rich source of phytonutrients such as fiber, potassium, iron, carotenoids, phenolic acid, flavonoids, and sulphur containing compounds, which exhibit excellent medicinal properties. Phenolic compounds mainly associated with oranges and orange juice based beverages are hydroxycinnamic acids (HCA) and flavonoids. Literature data show that flavanones are more predominant compared to HCAs and include naringenin, hesperetin, eriodictyol, and isosakuranetin while hydroxycinnamic acids mainly occur in esterification with ferulic, p-coumaric, sinapic and caffeic acids^{15, 16, 17}. The major pharmacological properties of oranges are attributed to hesperidin which has shown to possess anti-diabetic, anti-cancer, cardioprotective, anti-inflammatory, anti-arthritic, anti-hypertensive, anti-fungal, anti-bacterial and antioxidant activities^{18, 19}.

Green tea is one of the most popular beverages consumed throughout the world. Tea is obtained from the plant *Camellia sinensis* and is rich in polyphenolic compounds known as tea flavonoids. Green tea is obtained from the leaves of the tea plant that have not been subjected to fermentation. The health benefits of consuming the green tea include prevention of cancer and cardiovascular diseases, anti-inflammatory, anti-arthritic, anti-

bacterial, anti-angiogenic, anti-oxidative, anti-viral, neuroprotective and cholesterol-lowering effect^{20, 21, 22, 23, 24}. The chief components of green tea leaves that affect human health are caffeine, theophylline, essential oils and particularly polyphenolic compounds²⁵. Main polyphenolic compounds in green tea are catechins which are responsible for antioxidant activity and bitterness in green tea and include (-)-epicatechin-3-gallate (ECG), (-)-epigallocatechin (EGC), (-)-epicatechin (EC), and (-)-epigallocatechin-3-gallate (EGCG)²⁶. Many authors have reported that antioxidants exercise control over numerous biological activities, like suppression of oxidative enzymes and cancer-related transcriptional factors, quenching of reactive oxygen species, and metal chelation^{27, 28, 29, 30}. Studies have suggested that milk protein tends to associate with tea flavonoids due to which addition of milk in tea diminishes its antioxidant potential^{31, 32}.

Green tea, is an extremely good source of polyphenols and antioxidants has aroused the interest of health-conscious consumers in recent years for its consumption, however; astringency imparted by catechins and their instability at higher pH somehow limits its commercial application as a regular beverage. Fruit nectar based on orange is a sweetened beverage containing high fruit solids compared to other fruit beverages (min 40% as per FSSAI standards, 2011), is generally diluted with water, could present a convenient medium for blending with green tea as its delicious taste may overcome astringency of green tea while its antioxidant potential may be augmented by substitution of water with green tea. Moreover, the plenty of ascorbic acids present in orange nectar improves the bioavailability of green tea catechins. Scientific studies in human subjects have revealed that consumption of ascorbic acid improves the antioxidant potential of green tea polyphenols and inhibition of endogenous synthesis of N-nitroso compounds^{33, 34}. Therefore, the present study was undertaken to evaluate the feasibility of blending green tea and orange juice in different ratios for the manufacture of antioxidant enriched nutraceutical nectar.

MATERIALS AND METHODS:

Raw Materials: Green tea was procured from Quality Foods (Rohtak, Haryana) and oranges were

procured Reliance Fresh (Rohtak, Haryana). Folin-Ciocalteu's reagent, L-ascorbic acid, TPTZ, Trolox, ABTS, and gallic acid were purchased from Himedia (Mumbai, India). All the other chemicals were of analytical grade.

Preparation of Green Tea Extract: Green tea extract was prepared according to the method described by Hossain *et al.*,³⁵ with slight modifications. Briefly, green tea powder (30 g) was mixed with 300 ml distilled water and boiled for 50 min. The mixture was then filtered through Whatman filter paper to remove all the granular materials. To obtain a dry fine powder, the filtrate was lyophilized. 2 g of dry powder was dissolved in 100 ml water to obtain a working solution of green tea.

Extraction of Orange Juice: The slices of peeled oranges were taken. The slices were weighed after cleaning. The slices were then squeezed with hands in a muslin cloth, and the orange juice was thus obtained.

Preparation of Nectar Drink Blends: Different blends were prepared by mixing green tea and orange juice in different proportions as given in **Table 1**.

TABLE 1: BLENDS OF NECTAR DRINK WITH GREEN TEA AND ORANGE JUICE

Samples	Sugar (g)	Orange juice (ml)	Green tea (ml)
T ₀₁	10	100	-
T ₀₂	10	-	100
T ₁	10	40	60
T ₂	10	50	50
T ₃	10	60	40
T ₄	10	70	30

Chemical Analysis: The samples were analyzed for moisture content, ash content and titratable acidity as per standard AOAC³⁶ methods. Total soluble solids (TSS), pH and ascorbic acid were determined by methods given by Ranganna³⁷.

Total Phenols and Antioxidant Capacity:

Total Phenolic Content (TPC): Folin-Ciocalteu reagent method was used for total phenolic content determined as described by Ebrahimzaded *et al.*,³⁸ with some modifications. Briefly, 0.5 ml of each sample was mixed with freshly prepared Folin-Ciocalteu reagent (5 ml, 1:10 v/v with distilled water) for 5 min 4 ml of aqueous sodium carbonate solution (1M) was then added to the mixture. The

mixture was allowed to stand for 15 min, and the absorbance of the mixture was read at 765 nm. Total phenol values were expressed as mg of gallic acid equivalents per gram of samples.

Total Flavonoids: The total flavonoids content was determined by the colorimetric aluminum chloride method as described by Nabavi *et al.*,³⁹ with slight modifications. Briefly, 0.5 ml solution of each sample was dissolved in 1.5 ml of methanol, 0.1 ml of 10% aluminum chloride and 0.1 ml of 1M potassium acetate followed by addition of 2.8 ml distilled water. The mixture was incubated at room temperature for 30 min. The absorbance of the mixture was measured at 415 nm using a spectrophotometer.

Antioxidant Capacity Assays: The ferric ion reducing antioxidant power (FRAP) assay was conducted according to the method previously described by Benzie and Strain⁴⁰. Briefly, TPTZ (2.5 ml of 10 mM TPTZ in 40 mM HCl), 20 mM ferric chloride solution and 25 ml of acetate buffer (pH 3.6) were mixed in a ratio of 1:1:10 to prepare the oxidant. The reagent thus obtained was stable at room temperature for at least 3 h. FRAP reagent (160 μ l) was added to 40 μ l of undiluted beverage sample and then incubated for 30 min at 37 °C before measuring the absorbance at 593 nm. The 2,2-diphenyl-1-picrylhydrazyl radical scavenging capacity (DPPH) assay was conducted as per the method is given by Brand-Williams *et al.*⁴¹ To prepare the oxidant, 3.5 ml of DPPH stock solution consisting of 20 mg of DPPH in 100 ml methanol, with 6.5 ml of methanol was mixed. DPPH reagent (950 μ l) was mixed with 50 μ l of undiluted beverage sample, and then incubation was done for 1 h at room temperature. The absorbance of 200 μ l of the mixture was measured at 515 nm.

The Trolox equivalent antioxidant capacity (TEAC) assay was conducted according to the method described by Arts *et al.*⁴² 7.4 mM ABTS was mixed with 2.6 mM potassium persulfate to prepare the oxidant. The two solutions were left to react for at least 12 h at room temperature to create the ABTS + reagent. 1 ml of ABTS + with 10 ml of methanol was mixed with the resulting solution to obtain an absorbance of 1.5 units at 734 nm. 20 μ l of undiluted sample was added to 980 μ l of the diluted reagent, and the absorbance of 200 μ l of the

resulting mixture was measured at 734 nm. A stock solution of Trolox was prepared for each assay to a concentration of 20 mM in methanol. From the stock solution of Trolox, standards with concentrations of 200 to 1000 μ M (FRAP and DPPH) or 600 to 3000 μ M (TEAC) were freshly prepared before each assay. Results were expressed as micromoles of Trolox equivalents per 100 ml of sample.

Sensory Analysis: Sensory evaluation of nectar drink of green tea and orange juice was carried out in triplicate using a 9-point Hedonic scale by a panel of 10 semi-trained judges. Different nectar drink samples were evaluated for their color, taste, flavor and overall acceptability.

Statistical Analysis: The data were analyzed for mean standard deviation and critical deviation using OPSTAT version OPSTAT 1.exe (Hisar).

RESULTS AND DISCUSSION:

Physicochemical Characteristics of Orange Juice and Green Tea: The results regarding physicochemical characteristics of orange juice and green tea are presented in **Table 2**.

TABLE 2: PHYSICOCHEMICAL CHARACTERISTICS OF ORANGE JUICE AND GREEN TEA

Parameters	Orange juice (%)	Green tea (%)
Ash	0.38 \pm 0.01 ^b	0.20 \pm 0.01 ^a
Moisture	84.21 \pm 0.11 ^a	89.19 \pm 0.07 ^b
TSS	14.00 \pm 0.00 ^b	7.00 \pm 0.00 ^a
pH	3.45 \pm 0.00 ^a	5.85 \pm 0.00 ^b
Titrateable acidity	1.01 \pm 0.01 ^b	0.23 \pm 0.03 ^a

The values are expressed as the mean \pm SD of three independent determinations. The values of the means within rows with different superscript are significantly different ($P < 0.05$) from each other.

The samples were analyzed for different parameters, and significant differences ($p < 0.05$) were observed among the samples. Ash content was noted higher for orange juice and varied from 0.20% to 0.38% for green tea and orange juice respectively and. Sharma *et al.*,⁴³ observed similar ash content in orange juice in their study. Moisture content in orange juice was 84.21% and was comparatively lower than green tea with a moisture content of 89.19%. The high moisture content of green tea may be due to a high level of dilution during preparation. The higher relative amount of TSS content was noted for orange juice (12°B) as compared to green tea (7°B). The high sugar content of orange juice might have contributed to

the high TSS. The pH of green tea (5.85) was observed to be higher than orange juice (3.45). The TSS content of orange juice is in agreement with the findings of Stella *et al.*,⁴⁴ who reported 13.5°B TSS in orange juice. The value of titrateable acidity was recorded higher for orange juice (1.91%) while lower value was noted for green tea (0.23%). Organic acids are present in orange juice appreciable amount which might have contributed to the acidity level. The results for titrateable acidity in the present study are in alignment with previous findings of Rolle *et al.*⁴⁵

Physicochemical Properties of Nectar Drink Blends of Green Tea and Orange Juice:

Data about physicochemical properties of nectar drink blends are presented in **Table 3**. The moisture content of samples varied from 84.21% to 89.19% and a significant difference ($P < 0.05$) among all the samples was observed. Moisture content has an important, though indirect, effect on nutritional quality of nectar drink blends. The highest moisture content among all the blends was recorded for Treatment T₁ (87.65%). Treatments T₂, T₃, and T₄ displayed 86.71%, 86.02% and 85.88% moisture content respectively. The results indicated that the moisture content of blends decreased with an increase in the proportion of orange juice in the blends. The low moisture content of orange juice might be due to high total solids content possessed by orange juice as orange juice contains an appreciable amount of minerals. The high moisture content of the blends having a high proportion of green tea can be attributed to the higher level of dilution used for green tea preparation. Findings of Akuboor *et al.*,⁴⁶ reported a similar trend for moisture content comparable with that of the present study.

The ash content represents the total mineral content in foods and refers to the inorganic residue remaining after ignition or complete oxidation of organic matter in a food product. The ash content of prepared nectar drink was increased remarkably from 0.24% to 0.35% among blends with an increase in the orange juice concentration from 40-70 ml per 100 ml of the prepared nectar drink. The highest value of ash content was noted for Treatment T₄ (0.35%) having a high level of orange juice. Ash content varied significantly ($P < 0.05$) in all the blends.

The blends prepared with a high level of green tea displayed lower ash content. The results indicated that the values of ash content were influenced by the proportion of orange juice in the blends. Orange juice contains a high amount of minerals,

potassium being the predominant of all followed by phosphorus and magnesium. The values obtained for ash content for orange juice in the present study are in conformation with those reported by Sharma *et al.*,⁴³ in orange juice.

TABLE 3: PHYSICOCHEMICAL PROPERTIES OF NECTAR DRINK BLENDS OF GREEN TEA AND ORANGE JUICE

Parameters/ Treatment	Moisture (%)	Ash (%)	pH	TSS (°B)	Titratable Acidity (%)	Ascorbic Acid (mg/100 ml)
T ₀₁	84.21 ± 0.11 ^a	0.38 ± 0.01 ^f	3.45 ± 0.00 ^a	14.00 ± 0.00 ^e	1.01 ± 0.01 ^f	40.67 ± 0.02 ^f
T ₀₂	89.19 ± 0.07 ^f	0.20 ± 0.01 ^a	5.85 ± 0.00 ^f	7.00 ± 0.00 ^a	0.23 ± 0.03 ^a	2.34 ± 0.04 ^a
T ₁	87.65 ± 0.04 ^e	0.24 ± 0.02 ^b	4.12 ± 0.00 ^e	11.00 ± 0.00 ^b	0.72 ± 0.02 ^b	13.82 ± 0.05 ^b
T ₂	86.71 ± 0.05 ^d	0.28 ± 0.02 ^c	3.97 ± 0.00 ^d	12.50 ± 0.00 ^c	0.82 ± 0.03 ^c	24.72 ± 0.12 ^c
T ₃	86.02 ± 0.01 ^c	0.32 ± 0.01 ^d	3.72 ± 0.00 ^c	13.00 ± 0.00 ^d	0.89 ± 0.01 ^d	28.85 ± 0.09 ^d
T ₄	85.88 ^b ± 0.02 ^b	0.35 ± 0.01 ^e	3.53 ± 0.00 ^b	14.00 ± 0.00 ^e	0.94 ± 0.03 ^e	32.50 ± 0.13 ^e

The values are expressed as the mean ± SD of three independent determinations. The values of the means within columns with different superscript are significantly different (P<0.05) from each other.

The pH is an important parameter to measure the degree of acidity or alkalinity of a product. The data for pH of all the samples varied significantly (P<0.05) from 3.53 to 4.12. The lowest pH was found 3.45 for orange juice while highest pH was noted 5.85 for green tea. A decrease in pH was observed with increase in the level of orange juice in nectar drink blends. The result revealed that the reduction in pH of nectar drink might be due to an increase in acidity of the beverage as orange juice possesses a high content of vitamin C and citric acid. The low pH value of 3 to 4 may give the juice a good potential to check the growth of pathogenic bacteria^{47, 48}. Niu *et al.*,⁴⁹ reported similar pH values for orange juice in their study.

The values of TSS were observed to be significantly different (P<0.05) for all the samples except for treatments T₀₁ and T₄ which were found to be identical. The blend (T₁) with a high proportion of green tea displayed lowest TSS (11 °B) than all the other blends. The values for TSS of different blends varied from 11 °B to 14 °B. Orange juice displayed highest TSS so increase in the proportion of orange juice remarkably increased the TSS in prepared RTS drink. Orange juice has a high level of simple sugar inherent (sucrose, glucose, and fructose) which might have contributed to higher Brix level. The TSS of orange juice agrees with the findings of Rolle *et al.*⁴⁵

Total acidity is a measure of total acid present in the juice. The values of titratable acidity varied significantly (P<0.05) among all the nectar drink

blends and differed from 0.72% to 0.94%. Treatment T₁ had the lowest titratable acidity than other treatments. The highest value for titratable acidity was displayed by T₄ (0.94%) followed by T₃ (0.89%) and T₂ (0.82%). The blends prepared with a high level of orange juice were observed to have higher values of titratable acidity. The high titratable acidity of orange juice is because of its high acidic content, citric acid being the most abundant; followed by malic acid both being present mostly as free acids. Values obtained in this study are fairly within the range. Rolle *et al.*,⁴⁵ also reported similar results for titratable acidity of orange juice as observed in the present study.

The values of ascorbic acid ranged from 2.34 mg/100ml to 40.67 mg/100ml and a significant difference (P<0.05) was observed among all the samples of nectar drink. The highest value of ascorbic acid content was recorded for T₀ while the lowest value was recorded for T₁. Higher ascorbic acid content was displayed by blends T₄ (32.50 mg/100ml), and T₃ (28.85 mg/100ml) prepared with a higher proportion of orange juice as it contained an appreciable amount of vitamin C.

Vitamin C content is an important parameter for evaluating the nutritional value of the product. The content of vitamin C also influences the antioxidant activity of the product. The low ascorbic acid content in blends with high amount of green tea may be due to several factors including formulation (dilution level) and processing techniques as vitamin C is susceptible to heating. The present

results for ascorbic acid content are in accordance with the outcomes of Rolleet *al.*⁴⁵

Total Phenols and Antioxidant Capacity: The results obtained regarding total phenols, total flavonoids and antioxidant activity of nectar drink blends are presented in **Table 4**. A significant difference ($P < 0.05$) was observed among all the samples for all the parameters. Among all the samples, the highest value of phenolic content was recorded for T₀₂ (100.26 mg/100ml) while the lowest value was recorded for T₀₁ (70.15

mg/100ml). The TPC level in blends increased with the increased proportion of green tea in the formulation. The results are supported by the findings of Abountiolas *et al.*⁵⁰ The data collected for the total flavonoid content of different blends ranged from 30.29 mg/100ml to 49.12 mg/100ml. Green tea displayed the highest flavonoid content than all the other samples. Thus, blends formulated with a high level of green tea displayed higher flavonoid content. Nibiret *al.*,⁵¹ also reported similar results for total flavonoid content.

TABLE 4: TOTAL PHENOLS AND ANTIOXIDANT CAPACITY

Parameters/ Treatments	Total Phenol (mg/100ml)	Total Flavonoids (mg/100ml)	FRAP (mg/100ml)	DPPH (mg/100ml)	TEAC (μ mol/100ml)
T ₀₁	70.15 \pm 0.12 ^a	30.29 \pm 0.05 ^a	132.65 \pm 0.12 ^a	250.26 \pm 0.05 ^a	210.12 \pm 0.07 ^a
T ₀₂	100.26 \pm 0.11 ^f	49.12 \pm 0.03 ^f	790.42 \pm 0.09 ^f	748.13 \pm 0.02 ^f	876.23 \pm 0.05 ^f
T ₁	91.43 \pm 0.09 ^e	41.36 \pm 0.09 ^e	588.29 \pm 0.16 ^e	524.16 \pm 0.04 ^e	692.19 \pm 0.09 ^e
T ₂	86.35 \pm 0.17 ^d	38.82 \pm 0.04 ^d	454.35 \pm 0.11 ^d	458.21 \pm 0.03 ^d	548.31 \pm 0.02 ^d
T ₃	79.13 \pm 0.13 ^c	34.27 \pm 0.06 ^c	396.32 \pm 0.07 ^c	387.26 \pm 0.05 ^c	487.28 \pm 0.06 ^c
T ₄	74.24 \pm 0.15 ^b	32.75 \pm 0.02 ^b	292.19 \pm 0.12 ^b	312.17 \pm 0.04 ^b	374.21 \pm 0.03 ^b

The values are expressed as the mean \pm SD of three independent determinations. The values of the means within columns with different uppercase superscript are significantly different ($P < 0.05$) from each other.

Among all the samples, green tea exhibited highest FRAP activity (790.42 μ mol/100ml). Lower FRAP activity was displayed by the blends prepared with a high proportion of orange juice. The FRAP values for Treatments T₁, T₂, T₃ T₄ were observed to be 588.29, 454.35, 396.32 and 292.19 μ mol/100ml respectively. Total antioxidant activity of nectar drink was also evaluated using DPPH and TEAC. The DPPH value obtained for Treatment T₀₂ (748.13 μ mol/100ml) was significantly higher than other blends followed by Treatment T₁ (524.16 μ mol/100ml). The values for TEAC of blends of nectar drink showed similar trends and ranged between 210.12 μ mol/100ml and 876.23 μ mol/100ml. The results revealed that blends are having high green tea proportion contained significantly higher antioxidant activity than other

samples. Abountiolas *et al.*,⁵⁰ reported similar values for antioxidant activity of green tea and orange juice in their study. Al-Mamaryet *al.*,⁵² reported that there is a direct relationship between the phenolic content and antioxidant capacity of plants. The low antioxidant activity of orange juice might be due to the reduction of vitamin C content due to oxidation during the preparation of drink as vitamin C contributes to the antioxidant activity of orange juice. These results are by the observations of Rolleet *al.*⁴⁵

Sensory Analysis: Organoleptic quality is considered as a significant factor for the consumer's acceptability of the product. The sensory analysis of freshly prepared nectar drink blends was done using a nine-point hedonic scale.

TABLE 5: SENSORY EVALUATION OF DIFFERENT BLENDS OF NECTAR DRINK

Treatments acceptability	Colour	Taste	Mouthfeel	Overall
T ₀₁	8.60 \pm 0.15 ^f	8.93 \pm 0.12 ^f	8.70 \pm 0.05 ^f	8.74 \pm 0.08 ^f
T ₀₂	6.46 \pm 0.14 ^a	5.65 \pm 0.12 ^a	6.16 \pm 0.08 ^a	6.09 \pm 0.08 ^a
T ₁	7.16 \pm 0.08 ^b	6.36 \pm 0.08 ^b	6.50 \pm 0.03 ^b	6.67 \pm 0.03 ^b
T ₂	7.33 \pm 0.08 ^c	7.34 \pm 0.08 ^c	7.43 \pm 0.11 ^c	7.36 \pm 0.08 ^c
T ₃	8.23 \pm 0.08 ^d	8.13 \pm 0.03 ^d	8.30 \pm 0.03 ^d	8.22 \pm 0.03 ^d
T ₄	8.54 \pm 0.12 ^e	8.74 \pm 0.03 ^e	8.67 \pm 0.11 ^e	8.65 \pm 0.05 ^e

The values are expressed as the mean \pm SD of three independent determinations. The values of the means within columns with different superscript are significantly different ($P < 0.05$) from each other.

The orange juice sample (T₀₁) was found to be most acceptable followed by T₄ and T₃

respectively. The mouthfeel of treatments T₀₁, T₄ and T₃ scored higher than others. The better

mouthfeel may be attributed to the high total solid content of the samples. The lowest score for color, mouthfeel, and taste was scored for T₀₂. The high proportion of orange juice in blends may have improved the color, taste, and mouthfeel in blends resulting in higher overall acceptability. Therefore, T₄ blend had the highest overall acceptability score compared to other nectar drink blends.

CONCLUSION: The aim of the present study was focused on the development of nectar drink of orange juice and green tea. It can be concluded that orange juice can be a potential option to blend with green tea for the development of nectar drink with optimum sensory characteristics as it covered the bitter taste of green tea very successfully. The nutritious nectar beverage with good antioxidant potential could be developed by addition of orange juice up to a certain extent. The nectar beverage prepared by blending orange juice and green tea in equal proportion (50:50) was found better in enhancing almost all the sensorial quality as well as physicochemical parameters as compared to other combinations. The blended nectar with delectable sensorial attributes and improved nutrient characteristics could be pivotal in the commercialization of nutraceutical nectar at industrial scale.

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REFERENCES:

- Hertog MGL, Feskeens EJM, Holmann CH, Katan MB and Kromhout D: Dietary antioxidant flavonoids and risk of coronary heart disease: The Zutphen elderly study. *The Lancet* 1993; 342: 1007-11.
- Parkar SG, Stevenson DE and Skinner MA: The potential influence of fruit polyphenols on colonic microflora and human gut health. *International Journal of Food Microbiology* 2008; 124: 295-98.
- Lewandowska U, Fichna J and Gorlach S: Enhancement of anticancer potential of polyphenols by covalent modifications. *Biochemical Pharmacology* 2016; S0006-2952: 00021-26.
- Middleton EJ and Kandaswami CH: The impact of plant flavonoids on mammalian biology: implications for immunity, inflammation and cancer. *The Flavonoids: Advances in Research since 1986*. Chapman & Hall, London, 1993: 619-52.
- Hollman PCH and Katan MB: Dietary flavonoids: intake, health effects and bioavailability. *Food Chem Toxicol* 1997; 37: 937-42.
- Kaur CH and Kapoor HC: Antioxidants in fruits and vegetables- the millennium's health. *International Journal of Food Science and Technology* 2001; 36: 703-25.
- Tzounis X, Vulevic J, Kuhnle GG, George T, Leonczak J and Gibson GR: Flavanol monomer-induced changes to the human fecal microflora. *British Journal of Nutrition* 2008; 99: 782-92.
- FSSAI: Food Product Standards: Food Safety and Standards Act, Rules and Regulations. New Delhi: Akalank Publications, New Delhi, 2011: 202-54.
- Prior RL and Cao G: Antioxidant phytochemicals in fruits and vegetables: diet and health implications. *Hort Science* 2000; 35: 588-92.
- Sun J, Chu YF, Wu X and Liu RH: Antioxidant and anti-proliferative activities of common fruits. *Journal of Agricultural and Food Chemistry* 2002; 50: 7449-54.
- Guarnieri S, Riso P and Porrini M: Orange juice vs. vitamin C: effect on hydrogen peroxide-induced DNA damage in mononuclear blood cells. *British Journal of Nutrition* 2007; 97: 639-43.
- Lim YY, Lim TT and Tee JJ: Antioxidant properties of several tropical fruits: a comparative study. *Food Chemistry* 2007; 103: 1003-8.
- Liu J, Dong H, Chen B, Zhao P and Liu RH: Fresh apples suppress mammary carcinogenesis, proliferative activity, and induce apoptosis in the mammary tumors of the Sprague-Dawley rat. *Journal of Agricultural and Food Chemistry* 2008; 57: 297-04.
- Gliszczynska-S'wiglo A, Wroblewska J, Lemanska K, Klimczak I and Tyrakowska B: The contribution of polyphenols and vitamin C to the antioxidant activity of commercial orange juices and drinks. *Proceedings of 14th IGWT Symposium Focusing New Century: Commodity-Trade-Environment, China 2004*: 121-26.
- Kanitsar K, Arce L, Rios A and Valca'rcel M: Determination of phenolic constituents in citrus samples by on-line coupling of a flow system with capillary electrophoresis. *Electrophoresis* 2001; 22: 1553-65.
- Gil-Izquierdo A, Gil MI and Ferreres F: Effect of processing techniques at industrial scale on orange juice antioxidant and beneficial health compounds. *Journal of Agricultural and Food Chemistry* 2002; 50: 5107-14.
- Belajova E and Suhaj M: Determination of phenolic constituents in citrus juices: method of High Performance Liquid Chromatography. *Food Chem* 2004; 86: 339-43.
- Monforte MT, Trovato A, Kirjavainen S, Forestieri AM and Galati EM: Biological effects of hesperidin, a *Citrus* flavonoid. (Note II): Hypolipidemic activity on experimental hypercholesterolemia in rat. *II Farmaco* 1995; 50: 595-99.
- Tomas-Barberan FA and Clifford MN: Favanones, chalcones and dihydrochalcones-nature, occurrence and dietary burden. *Journal of the Science of Food and Agriculture* 2000; 80: 1073-80.
- Chacko SM, Thambi PT, Kuttan R and Nishigaki I: Beneficial effects of green tea: A literature review. *Chinese Medicine* 2010; 5: 13.
- Adak M and Gabar MA: Green tea as a functional food for better health: a brief review. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* 2011; 2(2): 645.
- Senanayake SP: Green tea extract: chemistry, antioxidant properties and food applications. *Journal of Functional Foods* 2013; 5: 1529-41.

23. Zhao C, Li C, Liu S and Yang L: The galloyl catechins contributing to main antioxidant capacity of tea made from *Camellia sinensis* China. *Scientific World Journal* 2014; article ID 863984.
24. Chen L, Mo H, Zhao L, Gao W, Wang S and Cromie MM: Therapeutic properties of green tea against environmental insults. *J of Nutritional Biochemistry* 2016; 40: 1-13.
25. Fukino Y, Ikeda A, Maruyama K, Aoki N, Okubo T and Iso H: Randomized controlled trial for an effect of green tea-extract powder supplementation on glucose abnormalities. *European Journal of Clinical Nutrition* 2007; 62: 953-60.
26. Chen Z and Chan P: Antioxidative activity of green tea catechins in canola oil. *Chemistry and Physics of Lipids* 1996; 82: 163-172.
27. Higdon JV and Frei B: Tea catechins and polyphenols: health effects, metabolism, and antioxidant functions. *Critical Reviews in Food Science and Nutrition* 2003; 43(1): 89-43.
28. Nichenametla SN, Taruscio TG, Barney DL and Exon JH: A review of the effects and mechanisms of polyphenolics in cancer. *Critical Reviews in Food Science and Nutrition* 2006; 46(2): 161-83.
29. Rathore K and Wang HC: Green tea catechin extract in the intervention of chronic breast cell carcinogenesis induced by environmental carcinogens. *Molecular Carcinogenesis* 2012; 51(3): 280-89.
30. Sarkar A and Bhaduri A: Black tea is a powerful chemoprevention of reactive oxygen and nitrogen species: comparison with its individual catechin constituents and green tea. *Biochemical and Biophysics Research Communication* 2001; 284(1): 173-78.
31. Langley-Evans SC: Antioxidant potential of green and black tea determined using the ferric reducing power (FRAP) assay. *International Journal of Food Science and Nutrition* 2000; 51: 181-88.
32. Robinson EE, Maxwell SRJ and Thorpe GHG: An investigation of the antioxidant activity of black tea using enhanced chemiluminescence. *Free Radical Research* 1997; 26: 279-93.
33. Klimczak I, Małeczka M, Szlachta M and Gliszczyńska-Świągło A: Effect of storage on the content of polyphenols, vitamin C and the antioxidant activity of orange juices. *Jou of Food Composition and Anal* 2007; 20(3-4): 313-22.
34. Vermeer IT, Moonen EJ, Dallinga JW, Kleinjans JC and Maanen JM: Effect of ascorbic acid and green tea on endogenous formation of N-nitrosodimethylamine and N-nitrosopiperidine in humans. *Mutation Research* 1999; 428: 353-61.
35. Hossain MS, Nibir YM, Zerin S and Ahsan N: Aqueous extract of Bangladeshi black tea exhibits antibacterial activities against multiple pathogenic bacteria. *Journal of Antimicrobial Chemotherapy* 2014; 129: 304-13.
36. AOAC: Official Methods of Analysis. Association of Official Analytical Chemists; Washington DC: USA, Edition 20th, 2000.
37. Ranganna S: Handbook of Analysis and Quality control of fruit and vegetable product. Tata McGraw Hill Publication Corporation limited, New Delhi, edition 2nd, 1997.
38. Ebrahimzadeh MA, Pourmorad F and Bekhradnia AR: Iron chelating activity screening, phenol and flavonoid content of some medicinal plants from Iran. *African Journal of Biotechnology* 2008; 32: 43-49.
39. Nabavi SM, Ebrahimzadeh MA, Nabavi SF, Hamidinia A and Bekhradnia AR: Determination of antioxidant activity, phenol and flavonoids content of *Parrotiapersica* Mey. *Pharmacologyonline* 2008; 2: 560-67.
40. Benzie IFF and Strain JJ: The ferric reducing ability of plasma (FRAP) as a measure of "Antioxidant Power": the FRAP assay. *Anal of Biochemistry* 1996; 239: 70-76.
41. Brand-Williams W, Cuvelier ME and Berset C: Use of a free radical method to evaluate antioxidant activity. *LWT-Food Science and Technology* 1995; 28: 25-30.
42. Arts T, Sebastian JD, Voss HP, Haenen M and Bast A: A new approach to assess the total antioxidant capacity using the TEAC assay. *Food Chemistry* 2004; 88: 567-70.
43. Sharma HP, Patel H and Sharma S: Enzymatic extraction and clarification of juice from various fruits-A review. *Trends in Post-Harvest Technology* 2014; 2: 01-14.
44. Stella SP, Ferrarezi AC, Santos KO and Monteiro M: Antioxidant activity of commercial ready-to-drink orange juice and nectar. *J of Food Science* 2011; 76: 392-97.
45. Rolle AC, Braesco V, Chupin J and Bouillot L: Nutritional composition of orange juice: A comparative study between French commercial and homemade juices. *Food Nutrition and Sciences* 2016; 7: 252-61.
46. Akuboor PI: The suitability of African bush mango juice for wine production. *Plant Foods for Human Nutrition* 1996; 49: 213-19.
47. Jay JM: *Modern Food Microbiology*. Aspen Publishers, Inc, Maryland, Edition 6th, 2000: 289.
48. Hatcher WS, Weihe JL, Splittstoesser DF, Hill EC and Parish ME: *Fruit beverages. Compendium of methods for the microbiological examination of food*. American Public Health Association Washington D.C. 1992.
49. Niu L, Wu JH and Liao X: Physicochemical characteristics of orange juice samples from seven cultivars. *Agricultural Sciences in China* 2008; 7: 41-47.
50. Abountiolas M and Nunes CD: Polyphenols, ascorbic acid and antioxidant capacity of commercial nutritional drinks, fruit juices, smoothies and teas. *International Journal of Food Science and Technology* 2018; 53: 188-98.
51. Nibir YM, Sumit AF, Akhand AA, Ahsan N and Hossain MS: Comparative assessment of total polyphenols, antioxidant and antimicrobial activity of different tea varieties of Bangladesh. *Asi Pac J of Trop Biomed* 2017; 7: 352-57.
52. Al-Mamary M, Al-Meerri A and Al-Habori M: Antioxidant activities and total phenolics of different types of honey. *Nutrition Research* 2002; 22: 1041-47.

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