Research Article

The Comparative Assessment of Nutrients and Anti-Nutrients Levels among Local and Branded Juices

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Abstract | Fruit drinks are suggested as the most appropriate replacement for fresh fruits. This research involves comparative assessment of nutritional and anti-nutritional ingredients found in local and branded juices. Seventeen samples of local and branded juice varieties were obtained from Hyderabad city local market. Three kinds of mango, apple and oranges were checked for their total phenolics (TPC) and total flavonoids (TFC) using the colorimetric technique and folin-Ciocalteu method. Other analysis included protein estimation by bradford method, metals (Fe, Zn) analysis by atomic absorption spectrophotometry and vitamin c analysis by titration method. Results depict that total protein was quite high in B1 orange juice, total phenolics and total flavonoids are significantly high in L3 orange juice among all the tested juices. Higher content of iron was found in L1 variety of apple and mango juice whereas B3 depicted increased iron levels among orange juice varieties. Higher zinc levels were found in Apple (B1) and Orange (B2 and L3) juice. Anti-nutritional component tannin was present in low amount in most of the selected juices, however, branded apple juice (B3) depicted higher tannin amount as compared to other juices. The study illustrates that those local juices which were seen to retain all nutrients and antioxidants can be replaced with branded juices as per consumer's affordability.

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Introduction

Citrus fruits and their derived juices have exceptional nutritional and health benefits due to their high nutritional value and significant vitamin C content. Furthermore, they also serve as a good source of several bioactive compounds such as flavonoids, phenolics, carotenoids, and contain iron, sodium, calcium, vitamin C, vitamin B, thiamine, riboflavin, niacin, folic acid etc. Minerals and vitamins needed by the human body can be gained by consuming fresh fruits or their juices (Lepaus *et al.*, 2023).

Juices can be produced at home or manufactured at small scale, however, most of their production is carried out in industrial plants. Evaluation of nutritional value of a juice can help the selection of juices according to suitability of consumer's nutritional needs and dietary goals (Kowalska *et al*., 2023). Apple (*Malus domestica*) comes out to be significant temperate fruit with 85% water, 11% crabs, 0.6% fat, 0.5% organic acids, 2% dietary fiber, and 0.3% protein. It contains malic acid as the most common acid as well as other acids including caffeic acid and chlorogenic acid. Apples are also an excellent source of fiber and vitamin C (120 mg/kg of fresh weight) while low in fat and sodium (Asma *et al*., 2023; Blicharz-Kania *et al*., 2023). A recent study has reported 13.8 of soluble fibre and 46.3 of insoluble fibre in local varieties of apple juice (Salinas *et al*., 2019). The mango (*Mangifera indica*) is among the second most popular fruits in the world and Pakistan is one of the biggest producer of this delicious fruit. Mangoes can either be concentrated in order to be utilized for longer time period or they may be used to produce fresh juices. Phytochemical analysis of mango pulp by a recent study revealed several antioxidant compounds and higher DPPH scavenging activity of mango pulp (Awan *et al*., 2024). Mango juices are considered as the most common non-alcoholic beverage consumed worldwide. Each cup of mango juice offers various micro and macronutrients like vitamins A and C, moderate to high quantities of carbohydrates, phytochemicals and antioxidants. Prominent mango polyphenols (identified in terms of their concentration in mango and free-radical scavenging power) are quercetin, mangiferin, catechins, kaempferol, rhamnetin, anthocyanins, gallic acid, benzoic acid, ellagic acids and protocatechuic acid. Inspite of natural added sugars such as sucrose, artificial Sweeteners like aspartame, sodium cyclamate, and saccharin are also found in branded mango juices (Islam *et al*., 2024). A recent study suggested that Sindhri mango possess a diverse range of phenolics as compared to Dussehri and Chaunsa. Processed mango juice may not always be considered as safe due to the micro-organisms susceptibility and storage conditions (Saeed and Jawed, 2023). Oranges (*Citrus sinensis* L.) are highly consumed fruits throughout the world due to their distinctive flavor, eye-catching color and a variety of bioactive compounds i.e., vitamin C, phenolic acids and carotenoids. However, these features may change during processing of oranges to juices. The source of this change may include heat effect, oxygen contact etc. which may result in modified browning index and viscosity in orange juices (Akyıldız *et al*., 2024). In spite of above mentioned nutritional components some of these fruits juices (e.g. apple juice) may have some anti-nutritional components like tannins which should be removed during processing of fruit to their respective juices. This is because tannins are polyphenolics which may cause proteins precipitation and thus prevent their utilization by the body (Shanker *et al*., 2024).

The present study is based on the objective of carrying out a nutritional assessment of nationally and regionally known juice brands to make consumers aware concerning the nutritional content and anti-nutritional components of various juice options. These evaluations play a critical role in helping customers make decisions that support their nutritional and health objectives.

Materials and Methods

Sample collection

We collected total seventeen juice samples from some national and international brands. Local and branded juice samples were chosen as per high availability, consumption rate, familiarity among local population and cost. Result analysis depicted the nutrient content in 100 ml of juice sample.

As the samples belonged to different companies so in order to avoid conflict these names were represented as codes. The juice names and respective codes are tabulated as follows.

Chemical and reagents

Folin-Ciocalteu's reagent, DPPH reagent, Iodine solution, Bradford's reagent, Ethanol, Standard protein solution, Bovine serum Albumin, phosphoric acid, Phosphate buffer, Gallic Acid, Saturated Sodium Carbonate, Starch, Ascorbic Acid solution.

Total protein analysis

Bradford's assay was used for total protein analysis. 2ml of phosphate buffer was added in 2ml sample, followed by centrifugation (15 minutes, 2000 rpm) to obtain the supernatant. 1 ml of the protein supernatant was added in Bradford's reagent, and absorbance was taken at 595 nm (Cappellucci *et al*., 2024).

Estimation of total phenolics

For both TPC and TFC, Juice sample (5ml) was added in buffer (25 ml) solution (80% methanol and 1% HCL), followed by mixing in a shaker bath, then centrifugation (15 minutes, 2000 rpm) to remove the supernatant.

Supernatant (0.5 ml), 2N Folin-Ciocalteu's reagent (5 ml) and saturated sodium carbonate (4 ml) were mixed and incubated at 50 °C for thirty minutes. The absorbance was recorded at 760 nm (Qureshi *et al.*, 2024).

Estimation of total flavonoid

Total flavonoids were estimated using aluminum chloride turbidimetric assay.

After adding 250 µL of the phenolic extract to 1.25 ml of distilled water, 75 µL of 5% NaN03, and letting it stand for 6 minutes, 150 µL of 10% AlCl3.6H2O was added, and it was again allowed to stand for 5 minutes. Finally, 500 µL of mol/LNaOH was added, and distilled water was added to bring the volume up to 2.5 ml. At 510 nm, absorbance will be measured right away against a blank that contains reagent mixture but no sample (Qureshi *et al.*, 2024).

Ascorbic acid estimation and DPPH Assay

Vitamin C was estimated using a previously reported titration method using iodine solution 20 ml Juice sample was filtered and 1m of the starch indicator solution plus 150 ml of purified water was added. The substance was titrated using an iodine solution. The titration's endpoint exhibits the first discernible hint of a dark blue-black tint brought on by the starch-iodine combination. Additional aliquots of the sample solution were used to repeat the titration process until the results agreed within 0.1 milliliters (Dike *et al.*, 2024).

For DPPH assay, 3ml of fruit juices extract were mixed with freshly prepared DPPH solution (98µg/ml), and allowed them to react in the dark at 27°C for half an hour. The DPPH solution in methanol served as positive whereas only methanol served as negative control. Absorbance (517 nm) was recorded via UV-VIS spectrophotometer (Khanzada *et al.*, 2021).

Estimation of metals

Estimation of metal content (both iron and zinc) was performed via Atomic Absorption Spectroscopy Perkin Elmer A800 (Kapoor *et al.*, 2024).

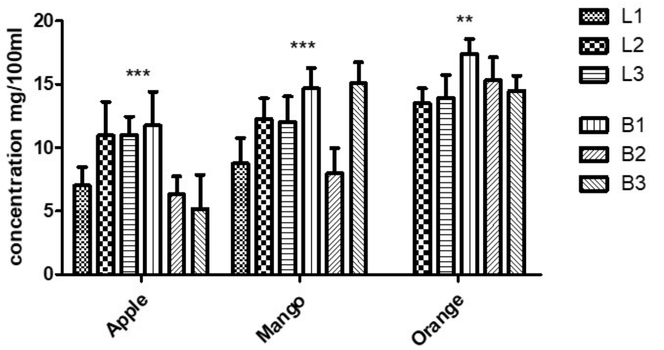
Estimation of tannin

Sample (1 ml) was mixed with Polyvinyl-polypyrolidone (10 mg), followed by mechanical shaking (3000 rpm). Extract (0.25 ml) were added in Folin-Ciocalteu's phenol reagent, following half hour, saturated sodium carbonate (2 ml) was added and sample was incubated at 50 °C for half hour. Absorbance was recorded at 760nm (Hossain *et al.*, 2024).

Results and Discussion

Total protein content

Figure 1 shows the comparison of the protein content and p-values in apple, mango, and orange juices for local (L1, L2, L3) and branded (B1, B2, B3) juices.



P value < 0.001***, P value <1.01**, Pvalue<0.05 *

Figure 1: *Comparison of protein content in local and branded juices.*

In apple and orange juice, B1, whereas in mango juice B1 and B3 were seen to have highest protein content followed by L2 and L3. In order to make most use of protein, we can prioritize L2 and L3 apple juices vs B2 and B3 possessing less protein. On the basis of such findings; it seems likely that local juices have a slightly lesser protein content compared to branded juices. It is consistent with previous studies done at Lahore, Pakistan, where local tetra pack juices were found to have very low protein content as compared to branded ones (Asad-Nawaz *et al.*, 2015).

Total phenolics determination

Total phenolics analysis (Figure 2) revealed contrasting results in case of apple and orange as both of these juices were found to have highest total phenol content in local juices instead of branded ones. It was found that L3 in case of orange and L2 in case of apple has a higher content of total phenolics compared to the branded juices. Following these results, it would be a wise decision to choose L3 over B2, owing to its higher phenolic. Moreover, it is generally recognized statement that you can select local juices instead of

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branded ones due to their easy availability at low cost (Schwartz *et al*., 2017).

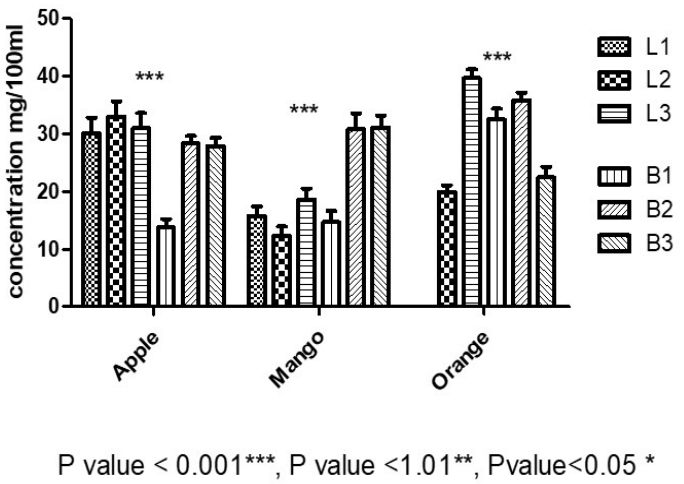

Figure 2: *Comparison of total phenolics in local and branded juices.*

Total flavonoid content

It is evident from Figure 3 that L1, L2, and L3 categories of local apple juices have increased flavonoids concentration as compared to B1, B2, B3. Therefore, it may be better to prefer these local apple juice choices than branded ones.

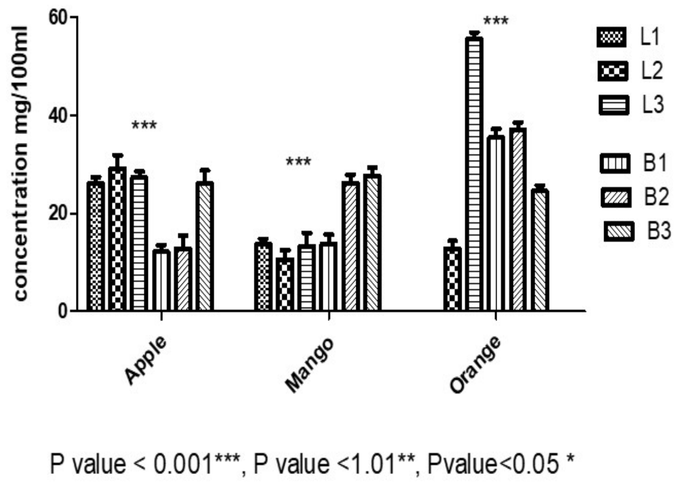

Figure 3: *Comparison of total flavonoid between local and branded juices.*

The flavonoid concentration in mango and orange juice can be discussed with a rational approach. Mango juice depicted higher flavonoid content for B2 and B3, and B1 has same flavonoids content as that of L1 and L3, it makes wise selection to choose L1 and L3 over B1 to accomplish the nutritional requirements. However, it is vital to consider several factors such as price, taste and availability. Research has shown that eating flavonoids rich food can increase an individual's daily intake of these phytochemicals by 50–800 mg, mostly via fruits and vegetables (Shen *et al*., 2022).

Table 1: *Juice names and codes.*

S. No.	Local juice samples	Codes
Juice names		
1	Apple national/local brand 1	Apple L1
2	Apple national/local brand 2	Apple L2
3	Apple national/local brand 3	Apple L3
4	Mango national/local brand 1	Mango L1
5	Mango national/local brand 2	Mango L2
6	Mango national/local brand 3	Mango L3
7	Orange national/local brand 2	Orange L2
8	Orange national/local brand 3	Orange L3
Branded juice samples		
1	Apple International brand 1	Apple B1
2	Apple International brand 2	Apple B2
3	Apple International brand 3	Apple B3
4	Mango International brand 1	Mango B1
5	Mango International brand 2	Mango B2
6	Mango International brand 3	Mango B3
7	Orange International brand 1	Orange B1
8	Orange International brand 2	Orange B2
9	Orange International brand 3	Orange B3

Estimation of ascorbic acid and DPPH assay

Figure 4 showed that apple and mango juice varieties L3 and L2 have significantly higher vitamin C content respectively. Whereas all branded as well as local orange juice selected in our study showed more or less similar vitamin C levels so consumer can prefer any of them as per affordability. Our results ae comparable with a recent research which reported high quantity of vitamin C (from 5.28 mg/100mL to 39.63 mg/100mL) in a variety of commercial fruit juices. It was also reported that around 40% of the vitamin-C amount is lost after package opening of marketable fruit juices and weekly storage at 4°C (Devolli *et al*., 2021).

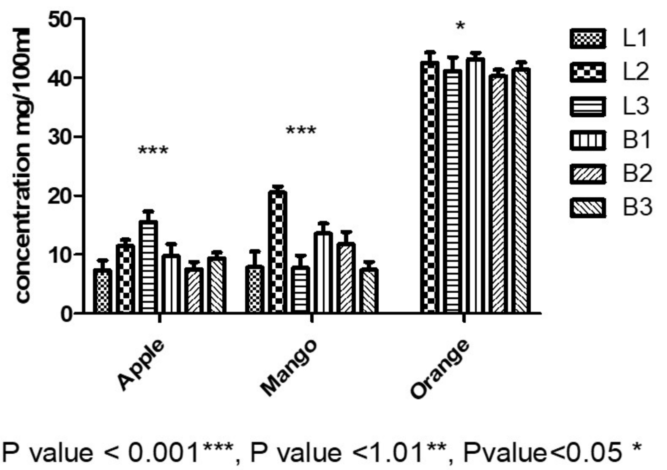

Figure 4: *Estimation of vitamin C in local and branded juice.*

Moreover, all the juices selected in our study either branded or local showed excellent DPPH scavenging ability (>80%) showing their antioxidant potential which may be due to presence of phenols and flavonoids. It may be noted from Table 2 that branded as well as local varieties of apple, mango and orange juices depicted more or less similar but very high DPPH scavenging (i.e. 89%). This reflects the strong antioxidant potential of local as well as branded juices selected in our study.

Table 2: *DPPH radical scavenging (%) in local and branded juices.*

Juice sample	DPPH radical scavenging (%)					
	L1	L2	L3	B1	B2	B3
Apple	89.31	89.43	89.14	89.26	89.44	89.44
Mango	89.43	88.37	89.28	89.1	88.75	89.04
Orange	--	88.59	89.27	87.92	87.66	89.44

Estimation of metal content

Iron content estimation results (Figure 5) show that L1 has higher concentration of iron in apple and mango juice, whereas B3 orange juice is iron rich. We can prioritize L1 mango juice over B3 if L1 and B3 have the similar iron content. It would be a practical decision to select the juices offering iron rich profile to accomplish your nutritional demands. Iron is indispensable for the immune system, temperature regulation, cognitive development energy metabolism, and job routine etc. (Wensveen *et al*., 2024).

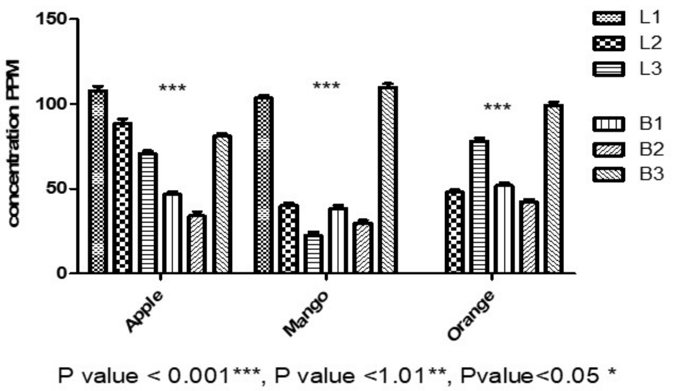

Figure 5: *Comparison of iron in local and branded juices.*

As far as the zinc estimation is concerned, in apple juice B1 showed higher zinc levels than others, whereas, in mango and orange juice B2 has higher zinc content (Figure 6). However, L3 variety in orange juice may be preferred over B2 because of almost similar zinc levels. This would be a practical attitude in order to accomplish zinc requirements for a wider range of folks.

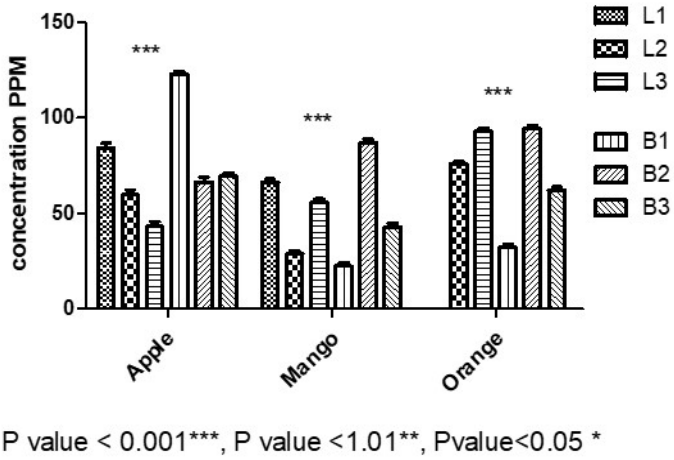

Figure 6: *Comparison of total zinc in local and branded juices.*

Estimation of total tannin

As per our results, branded apple juices (particularly B3) were found to have higher tannin content so they must be replaced with local ones (Figure 7). In case of orange L3, whereas in case of apple both L1 and L2 can be chosen by consumers due to lower tannin content. Mango L3 juice showed least tannin content so it could be preferred over other juice varieties. A recent report documented the increase in bitterness of cider due to its high tannin content, consumer mostly do not prefer such high tannin apple juices due to this bitter flavor (Zakalik and Peck, 2023).

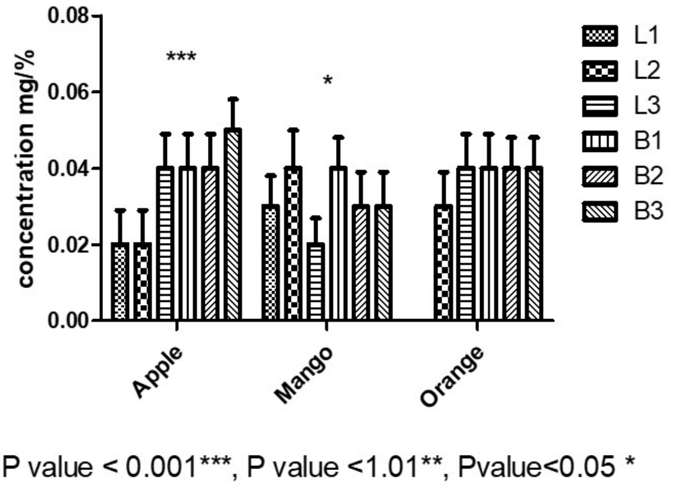

Figure 7: *Comparison of Tannin between local and branded juices.*

Fruit juices should have lower tannin content, which makes them safe and digestible to drink. In the biological system, chelation of proteins by tannins is reported, which can prevent digestion. Compounds like tannins categorized as anti-nutrients may cause impaired digestion, utilization and absorption of nutrients (Singh *et al*., 2023). This drawback is not so concerning for majority of people but it may be problematic in persons with specific dietary needs like malnutrition, or in people who rely almost exclusively on cereals and legumes (Krishna *et al*., 2024).

Conclusion

The findings from the present study suggested that selected fruit juices were rich in phenols and flavonoids, protein, vitamin C, iron and zinc. High amount of Iron was found in apple local juice (L1), a comparable high protein content in local juice, whereas maximum amount of zinc and phenolics were found in branded juice. We recommend that persons with a protein and iron deficiency may consume Orange and mango B1 and B3 juices as showed highest protein and iron content respectively. Moreover, orange juice local varieties L3 is suggested for higher intake of phenolics and flavonoids. The selected branded juices had higher tannin content particularly apple juice depicted highest tannin content. Therefore, this study provides a valuable information regarding selection of fruit juice choices for consumers as they should opt for low tannin and high protein, and flavonoid rich juices as per their affordability.

Author's Contribution

Neelam Bhutto: Investigation, methodology, writing.
Ibtessam Tahir Ansari: Conceptualization, supervision, project administration.
Beenish Khanzada: Formal analysis, writing, review and editing.
Mumtaz Ali Sahito: Data curation.
Zainab Abeer Ansari: Validation, visualization, resources.

Data availability
Data requested will be provided as per request.

Funding statement
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Conflict of interest
The authors have declared no conflict of interest.

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