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Comparative assessment of physicochemical properties of unripe peach (*Prunus persica*) and Japanese apricot (*Prunus mume*)

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PEER REVIEW

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Comments

This is a valued study in which authors have evaluated the potential usefulness of unripe peach fruits on the basis of nutritive value as well as mechanical and sensory properties. Moreover, authors have depicted a greater functional benefit of unripe peach fruits in terms of the cancer reducing properties.
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ABSTRACT

Objective: To investigate the physicochemical properties of unripe peach-*Prunus persica* cv. Mibaekdo (Mibaekdo) and *Prunus persica* cv. Nagasawa Hakuho (Nagasawa Hakuho) as an alternative to food supplement while Japanese apricot (*Prunus mume* cv. Backaha) (Backaha) was used as a control sample.

Methods: The unripe fruits were analyzed for soluble solid (°Brix), titratable acidity, pH, total polyphenol content, 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity, amygdalin content, free amino acid content, organic acid content, free sugar content, and α-amylase activities.

Results: Total polyphenol content of unripe peach ranged between 137.27-151.64 μg/g whereas that of apricot was 160.73 μg/g. DPPH radical scavenging activities of Backaha was the highest (89.16%) followed by Mibaekdo (85.05%) and Nagasawa Hakuho (41.50%). The highest amount of oxalic acid (612.8 mg/100 g) was observed in Mibaekdo while that of Nagasawa Hakuho and Backaha were (184.6±18.1) and (334.8±16.1) mg/100 g, respectively. Amygdalin contents of Mibaekdo, Nagasawa Hakuho and Backaha were 486.61, 548.60 and 174.28 μg/g, respectively.

Conclusions: The results suggest that the unripe fruit of peach has a significant biochemical potential of using as a food supplement with potential health benefit for human health.

KEYWORDS

Amygdalin, Japanese apricot (Backaha), Physicochemical properties, Unripe peach (Mibaekdo, Nagasawa Hakuho)

1. Introduction

Peaches (*Prunus persica* L. Batsch, Rosaceae) are native to China. However, they are extensively cultivated in various parts of the world specially countries with cooler climate. The peach fruit develops from a single ovary that ripens into a fleshy, juicy exterior, making up the edible part of the fruit, and a hard interior called the stone or pit. The flesh of the fruit adheres firmly to the stone[1]. Outer skin of the fruit is reddish-yellow in color, while the flesh is either white or yellow. Peaches having white flesh are usually sweeter and with lesser acidity than that of the yellow-fleshed ones, which typically have an acidic tang, coupled with sweetness. Climate, cultivation practices and cultivar differences were some of the factors that affected the phytochemical contents of fruits[2]. Moreover, even within

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the same fruit organic acids, carbohydrates and phenolics were not homogeneously distributed, and most of which were accumulated in the epidermal and sub-epidermal layers of fruit[3].

Peaches are considered as important economic crops and are recommended for their various health benefits[4]. Caffeoylquinic acid, a bioactive polyphenol with significant antioxidant activity and having an important beneficial effect in human health[5] was found in high concentration during early stage of peach development[6]. Generation of reactive oxygen species in human blood plasma can be minimized and thus provide a potential protection against various chronic diseases with dietary consumption of peach[7].

Peach is a potential source of bioactive compounds, carrying medicinal benefits[8]. Quality of fruit is traditionally evaluated based on physical characteristics, such as surface color, shape, and firmness[9,10]. Among several qualities such as sensory properties (appearance, texture, taste and aroma), nutritive value and mechanical properties, sensory properties of fruits are vital in consumer satisfaction[11].

Because of high potentiality of medicinal benefit, there is an increasing demand for stone fruits including peach whereas problems related to their processing have raised concerns among large number of consumers. However, there is little information exists on the potential of using the unripe peach fruit. This part can have diverse physicochemical properties important for health benefits. Such parameters may vary greatly among different cultivars. In the present study, it was aimed to investigate the physicochemical properties such as soluble solid (°Brix), titratable acidity, pH, total phenolics content, 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity, amygdalin content, free amino acid content, organic acid content, free sugar content, and α-amylase activities of unripe peach of two different cultivable varieties (Mibaekdo and Nagasawa Hakuho) as alternative to food supplement.

2. Materials and methods

2.1. Samples and chemicals

Unripe fruits of Mibaekdo and Nagasawa Hakuho cultivars of peach, grown at Cheongdo Peach Experiment Station of Cheongdo-city in Korea, were manually harvested at 30~35 d after flowering and transported to the laboratory at School of Applied Biosciences, Kyungpook National University, Daegu, Korea. Japanese apricot (*Prunus mume* Sieb. et Zucc. cv. Backaha) fruit sample was purchased at a local market in Daegu, Korea. The intact fruits were sorted and washed several times with tap water, followed by repeated rinsing in deionized water before using in experiments. Amygdalin standards were purchased from Sigma-Aldrich (St. Louis, MO, USA). All other chemicals used in the study were of analytical-reagent grade.

2.2. Measurement of length, width and weight

Ten fruits of each cultivar were randomly sampled and measured for length, width and weight. Fruit weight was measured using an electronic analytical digital scale balance (GT 480, Ohaus, Korea), and length and width with a caliper (CD-20B, Mitutoyo Co., Japan).

2.3. Rheological measurement

Hardness, cohesiveness, springiness and brittleness of fruits were measured in triplicate by a rheometer (COMPAC-100, Sun scientific Co., Japan) under the following operational conditions: test type, mastication; probe, 25 mm aluminium cylinder probe; load cell, 2.0 kg and table speed, 60 mm/min.

2.4. Color measurement

Color of the fruit was measured using a portable Minolta Chroma Meter CR-200 (Minolta Camera Co. Ltd., Osaka, Japan). Results were recorded as L*, a*, and b* values, where L* describes lightness, a* redness (-a* greenness), and b* yellowness. Four measurements were made at different locations on each sample and averaged.

2.5. Standard chemical analysis

Some of the physicochemical properties of fruits like pH, titratable acidity and soluble solids were determined. The pH was measured using a pH meter (Orion 420A, USA). Measurement of titratable acidity was carried out by titrating 10 mL of unripe peach juice to 100 mL of deionized water. Titratable acidity was expressed as % tartaric acid. Soluble solid content expressed as Brix was determined by a refractometer (RX-5000α, Atago, Tokyo, Japan).

2.6. Determination of total phenolics compounds

The contents of total phenolics in fruit extracts were analyzed following Folin-Ciocalteu colorimetric method[12]. The photometric measurement was carried out at 750 nm allowing reagents to react for 60 min by ELISA reader (Infinite F50, Tecan, Switzerland). Gallic acid was used as a standard for the calibration curve, and results were expressed as μg/g on a dry weight basis of sample, and the values are presented as means of triplicate analyses.

2.7. Determination of DPPH radical scavenging activity

The DPPH radical scavenging activity of fruit juice was estimated according to the method of Blois[13]. DPPH

solution was prepared at the concentration of 4×10^{-4} mol/L in methanol. A 0.1 mL of fruit juice was mixed with 2.9 mL of DPPH solution. The mixture was incubated at room temperature for 30 min, and then absorbance was measured at 517 nm by ELISA microplate reader (Sunrise basic, Tecan, Austria). The control was prepared without mixing any fruit extract, and methanol was used for the baseline correction. Radical scavenging activity was expressed as the inhibition percentage and calculated using the following equation:

Radical scavenging activity (%)=(control OD-sample OD/control OD)×100.

These experiments were run in triplicate.

2.8. Determination of amygdalin

As soon as the fresh fruits were sampled, they were ground by means of a blender. The ground samples were preserved at -80 °C until they were analyzed. A 2 g of sample was extracted with 50 mL of methanol in the Soxhlet equipment for 6 h. Methanol was evaporated at 40 °C using an evaporator. The residue was dissolved in 10 mL of mobile phase (CH_3CN:H_2O). The sample was passed through Sep-Pak C_{18} cartridge preconditioned with CH_3CN and H_2O[14]. Conditions for the HPLC were: detector, Waters, US/M996, 717 plus photodiode array detector; column, μ Bondapak C_{18} 10 μm 125A; mobile phase, 25% CH_3OH; column temperature, 30°C; flow rate, 1.0 mL/min; UV detector, 214 nm; injection volume, 10 μL. The amygdalin content was determined by comparing the obtained peaks with the standards ones according to their relative rise and time. Samples were run in duplicate.

2.9. Free amino acids profile

The freeze-dried samples were ground into fine particle and sieved (100 mesh) for chemical analysis. One gram of sample powder was diluted in 10 mL of 3% trichloroacetic acid solution, left at room temperature for 1 h, and centrifuged at 19 319 ×g for 15 min. The collected supernatant was filtered through a Millipore 0.22-syringe filter. Amino acids were separated using an automatic amino acid analyzer (Biochrom 20, Pharmacia Biotech Co., Sweden). Each filtered sample solution of 10 μL was injected. All determinations were done in duplicate.

2.10. Organic acid determination

Organic acid concentration was measured by HPLC. Standards of pure organic acids (malic, citric and oxalic acid) were prepared at 1 mg/mL in ultrapure water (Milli-Q water purification system, Millipore Australia Lty Ptd) as well as a standard mixture (of all acids) for calibration curves at various final concentrations. Samples were also prepared by extraction of ground freeze-dried samples. The samples were flushed with nitrogen and centrifuged at 2 000 r/min for 15 min. One milliliter of sample was added to 9 mL of distilled water and placed overnight at room temperature and filtered through 0.22 μm syringe filter (Millipore, USA). Conditions for the HPLC were: detector, waters, US/M996; refractive index detector (RI, model 410); mobile phase, 0.005 mol/L H_2SO_4 in water; column, PL Hi-Plex H, 300×7.7 mm; column temperature, 65 °C; flow rate, 0.6 mL/min; injection volume, 10 μL.

2.11. Free sugar determination

Free sugars were analyzed following the method of Genard and Souty[15]. A 5 g of sample was added to 10 mL of distilled water and homogenized using a homogenizer (Ultra-Turrax T-25, IKA-Labortechnik, Germany), then added with 20 mL of distilled water, followed by centrifugation at 16 000 ×g for 30 min. The supernatant was collected and filtered through a Sep-Pak C_{18} cartridge (WAT023501, Waters, USA) and a Millipore 0.45-syringe filter (PVDF, Whatman, Japan). Free sugars were quantified using an HPLC (Model 9300, Younglin, Korea) consisting of a refractive index detector (Triathlon M730D, Younglin, Korea), a column heater set at 85 °C, and Sugar-Pak (6.5× 300 mm Alltech, USA); the mobile phase was deionized-distilled H_2O delivered at 0.5 mL/min. Glucose, fructose, sucrose and sorbitol, obtained from Aldrich Chemical Co. Inc. (Milwaukee, WI, USA), were used as reference sugars for identification, and manitol as the internal standard. Free sugars were expressed as mg/100 g of fruit.

2.12. Statistical analysis

Data were subjected to One-way or Two-way analysis of variance (ANOVA) when required. Differences between means at $P<0.05$ were identified using the Tukey's means test and the statistic version 4.0 package (Analytical Software, AZ, USA) was used for data analysis.

3. Results

3.1. Length, width and weight of fruit

The width of two cultivars of peach, Mibaekdo (38.24 mm) and Nagasawa Hakuho (32.59 mm), were significantly different as shown in Table 1. Width of Backaha apricot was non-significantly different from that of Nagawawa Hakuho peach, however, length of apricot (35.64 mm) was significantly lower than that of both cultivars of peach, Mibaekdo (37.94 mm) and Nagasawa Hakuho (37.06 mm). Backaha apricot and peach cultivars did not show any significant differences in their fruit weight, which ranged between 20.44-21.41 g.

Table 1
General compositions of unripe peaches (Mibaekdo and Nagasawa Hakuho) and Japanese apricot (Backaha).

Parameter	Cultivar		
	Mibaekdo	Nagasawa Hakuho	Backaha
Width (mm)	38.24±1.72[a]	32.59±2.08[b]	32.49±1.45[b]
Length (mm)	37.94±2.32[a]	37.06±2.40[a]	35.64±1.65[b]
Weight (g)	21.41±2.87[a]	20.44±2.89[a]	21.24±3.08[a]
Hardness (10^2×dyne/cm^2)	155±1.2[b]	217±0.5[a]	129±0.7[c]
Cohesivness	36.99±0.03[b]	39.36±0.02[a]	32.45±0.02[c]
Springness (%)	69.50±0.02[b]	65.32±0.03[c]	91.18±0.02[a]
Brittleness (g)	265.50±9.30[c]	476.28±8.30[a]	345.00±6.71[b]
L (lightness)[1]	66.67±1.20[a]	65.13±0.57[a]	45.59±0.32[b]
a (redness)	−13.52±1.09[a]	−12.64±0.72[a]	−12.00±1.72[a]
b (yellowness)	27.35±1.97[a]	25.72±2.31[a]	24.04±1.77[a]
Soluble solids (°Brix)	7.7±0.2[a]	7.9±0.2[a]	7.5±0.1[b]
Titratable acidity (% tartaric acid)	0.311±0.021[b]	0.370±0.041[a]	0.379±0.021[a]
pH	4.04±0.01[a]	3.94±0.03[b]	2.75±0.04[c]

The values with different letters in the same row (a–c) are significantly different (P<0.05). Each value is the average of triplicate measurements. 1) L: lightness (100, white; 0, black), a: redness (–, green; +, red), b: yellowness (–, blue; +, yellow).

3.2. Texture of fruit

Table 1 depicts that the unripe Nagasawa Hakuho peach showed a significantly higher levels of hardness (217 dyne/cm^2) than that of Mibaekdo peach (155 dyne/cm^2) and both the varieties of peach were harder than Backaha apricot (129 dyne/cm^2). Increased hardness in the unripe Nagasawa Hakuho imparted greater cohesiveness (39.36) and brittleness (476.28 g) than that in Mibaekdo peach and Backaha apricot. Backaha apricot (91.18%) possessed significantly the highest springiness than that of Nagasawa Hakuho (65.32%) and Mibaekdo (69.50%) peaches.

3.3. Color value of fruit

The two varieties of peach did not show any significant variation in color expression (Table 1). Backaha apricot showed significantly less lightness (45.59) than Mibaekdo (66.67) and Nagasawa Hakuho (65.13) peaches. Redness and yellowness were not statistically different among the fruits.

3.4. Soluble solid (°Brix), titratable acidity (%) and pH

The soluble solids content (°Brix) level in the two cultivars of peach, Nagasawa Hakuho (7.9 °Brix) and Mibaekdo (7.7 °Brix), was not significantly different (Table 1). The peaches, however, contained significantly higher soluble solids content than the Backaha apricot (7.5 °Brix). Titratable acidity, measured as % tartaric acid, was significantly higher in Magasawa Hakuho peach (0.370%) and Backaha apricot (0.379%) than in Mibaekdo peach (0.311%). Value of pH declined with increase in soluble solids content and titratable acidity of the peach cultivars where Midaekdo peach was of higher pH (4.04) than in Nagasawa Hakuho (3.94). Even though titratable acidity was higher in the Backaha apricot than was in the peaches, soluble solids and pH were significantly lower in the Backaha apricot than was observed in the two cultivars of peach.

3.5. Total phenol content and DPPH radical scavenging activity

Mibaekdo peach was higher in total phenol content (151.64 μg GAE/g) and DPPH (85.05%) than the Nagasawa Hakuho peach (137.27 μg GAE/g total phenol and 41.50% DPPH). Backaha apricot was superior in antioxidant capacity (160.73 μg GAE/g total phenol content and 89.16% DPPH) than the peach cultivars (Table 2) giving the Backaha apricots a significantly higher potential to protect against cellular damage caused by exposure to high levels of free radicals.

Table 2
Total phenol content, DPPH radical scavenging activity and amygdalin content of unripe peaches (Mibaekdo and Nagasawa Hakuho) and Japanese apricot (Backaha).

Cultivar	Total phenols (μg GAE/g on a dry basis)	DPPH (% on a dry basis)	Amygdalin (μg/g on a dry basis)
Mibaekdo	151.64±13.51[a]	85.05±1.05[b]	486.61±12.31[b]
Nagasawa Hakuho	137.27±12.11[b]	41.50±2.03[c]	548.60±10.22[a]
Backaha	160.73±10.11[a]	89.16±1.07[a]	174.28±14.11[c]

The values with different letters in the same column (a–c) are significantly different (P<0.05). Each value is the average of triplicate measurements.

3.6. Amygdalin content of fruit

Though Backaha apricot produced higher antioxidant activity than the peaches, they contained significantly lower (174.28 μg/g) amygdalin than what pertained in the peaches (Table 2). The Mibaekdo peach contained significantly lower amygdalin content of 486.61 μg/g as compared to Nagasawa Hakuho peach (538.60 μg/g).

3.7. Free amino acid, organic acid and free sugar content

Free amino acids showed varied degrees of concentration in the samples as shown in Table 3. Total free amino acid content was higher in Backaha apricot (1 633.51 μg/100 g dry weight) than in either cultivar of peach, Mibaekdo (1 524.28 μg/100 g dry weight) and Nagasawa Hajuho (1 407.96 μg/100 g dry weight). Phosphor-L-serine, taurine, phosphor ethanol amine, urea, sacosine, a-amino-n-butyric acid, cysteine, methionine, cystathionine, amino-iso-butyric acid, hydroxylysine, ornithine, tryptophan, methyl histidine, anserine, and carnosine were not detected in any of the 3 fruit samples. Relatively high concentrations of essential amino acids such as serine, asparagine, aspartic acids, threonine, serine, and alanine were found in the samples while glycine, glutamic acid, tyrosine, lysine, and histidine were relatively low. Alanine was only synthesized in the Mibaekdo peach but not in the other samples. The highest and most significant isoleucine accumulation (38.76 μg/100 g dry weight) occurred

in the unripe Mibaekdo peach followed by Backaha apricot (21.68 μg/100 g dry weight). The unripe Nagasawa Hakuho peach produced significantly low isoleucine (7.16 μg/100 g dry weight). In measuring the organic acid content, the highest accumulation of oxalic acid (612.2 μg/100 g dry weight), tartaric acid (301.0 μg/100 g dry weight) and lactic acid (314.7 μg/100 g dry weight) were found in Mibaekdo peach (Table 4). Mibaekdo peach contained lower malic acid (176.9 μg/100 g dry weight) as compared to the Nagasawa Hakuho peach (495.5 μg/100 g dry weight) and Backaha apricot (185.1 μg/100 g dry weight). None of the fruits showed significantly different lactic acid content but oxalic acid and tartaric acid differed significantly. The difference in malic acid content in Mibaekdo peach and Backaha apricot was statistically insignificant.

Table 3

Free amino acid of unripe peaches (Mibaekdo and Nagasawa Hakuho) and Japanese apricot (Backaha) (μg/100 g dry weight).

Amino acid	Cultivar		
	Mibaekdo	Nagasawa hakuho	Backaha
O-Phospho-L-serine	ND	ND	ND
Taurine	ND	ND	ND
O-Phosphoethanolamine	ND	ND	ND
Urea	ND	ND	ND
L-Aspartic acid	37.15	46.58	52.24
Hydroxy-L-proline	ND	ND	ND
L-Threonine	44.60	23.92	27.89
L-Serine	137.79	39.12	99.14
L-Asparagine	748.59	941.95	959.29
L-Glutamic acid	23.70	26.09	43.83
L-Sarcosine	ND	ND	ND
L-a-Aminoadipic acid	7.51	ND	ND
L-Proline	82.68	ND	ND
Glycine	5.34	3.12	4.62
L-Alanine	44.42	43.33	43.78
L-Citrulline	24.44	17.82	ND
L-a-Amino-n-butylric acid	ND	ND	ND
L-Valine	33.34	13.18	20.33
L-Cystine	ND	ND	ND
L_Methionine	ND	ND	ND
Cystathionine	ND	ND	ND
L-Isoleucine	38.76	7.16	21.68
L-Leucine	31.35	8.23	19.20
L-Tyrosine	10.53	7.33	8.06
B-Alanine	15.94	ND	ND
L-Phenylalanine	49.49	12.80	18.48
D,L-B-Aminoisobutyric acid	ND	ND	ND
L-Homocystine	ND	ND	ND
r-Amino-n-butyric acid	30.18	49.74	61.37
Ethanolamin	10.47	10.16	ND
Ammonium Chloride	95.51	116.18	199.11
Hydroxylysine	ND	ND	ND
L-Ornithine	ND	ND	ND
L-Lysine	7.38	4.55	8.77
1-Methyl-L-histidine	ND	ND	ND
L-Histidine	23.02	6.69	15.71
L-Tryptophan	ND	ND	ND
3-Methyl-L-histidine	ND	ND	ND
L-Anserine	ND	ND	ND
L-Carnosine	ND	ND	ND
L-Arginine	21.99	29.94	29.94
Total	1524.28	1 407.96	1 633.51

Each value is the average of triplicate measurements. ND: not detected.

Table 4

Organic acid content of unripe peaches (Mibaekdo and Nagasawa Hakuho) and Japanese apricot (Backaha) (mg/100 g dry weight).

Cultivar	Oxalic acid	Tartaric acid	Malic acid	Lactic acid
Mibaekdo	612.8±20.1[a]	301.0±13.3[a]	176.9±10.1[b]	314.7±15.1[a]
Nagasawa Hakuho	184.6±18.1[c]	258.5±19.2[b]	495.5±25.1[a]	310.0±20.1[a]
Backaha	334.8±16.1[b]	165.4±15.1[c]	185.1±24.1[b]	302.8±20.5[a]

The values with different letters in the same column (a-c) are significantly different ($P<0.05$). Each value is the average of triplicate measurements.

Free sugars such as sucrose, glucose, fructose, and sorbitol content of the unripe peach, varied significantly in different pattern (Table 5). Glucose and fructose contents were the lowest in Mibaekdo peach whereas Backaha apricot contained the highest amount of glucose (460 mg/100 g fresh weight) and Nagasawa Hakuho peach possessed the highest amounts of fructose (804 mg/100 g fresh weight), but had the lowest sucrose (12.4 mg/100 g fresh weight) content. Sorbitol (620 mg/100 g fresh weight) and sucrose (140 mg/100 g fresh weight) content of Backaha apricot were significantly higher than either cultivar of peach.

Table 5

Free sugar content of unripe peaches (Mibaekdo and Nagasawa Hakuho) and Japanese apricot (Backaha)[1] (mg/100 g fresh weight).

Cultivar	Sucrose	Glucose	Fructose	Sorbitol
Mibaekdo	86.6±7.9[b]	285.6±6.7[c]	101.8±9.1[c]	283.0±10.1[b]
Nagasawa Hakuho	12.4±5.9[c]	398.3±9.1[b]	804.0±7.7[a]	144.2±12.3[c]
Backaha	140.0±8.7[a]	460.0±8.7[a]	540.0±1.5[b]	620.0±11.1[a]

[1]-The values with different letters in the same column (a-c) are significantly different ($P<0.05$). Each value is the average of triplicate measurements.

4. Discussion

The variation in physical properties of peaches and Backaha apricot could be influenced by chelate-soluble pectin, which was found to give parallel linkages or intertwists between the basic units of fruit development affecting fruit physical properties such as width, length and fresh weight in yellow peaches[16].

Softening of fruit during ripening might be due to pectin metabolism caused by polygalacturonase[17]. The variation in hardness or firmness and other physical properties of the fruits could therefore be due to differences in pectin, which plays a central role in fruit ripening. Pectin accumulation correlates with maturity and helps elucidate the mechanism of fruit softening at the molecular level and maintaining the post-harvest quality of peaches[17]. Firmer fruits and vegetables contain higher percentages of wide and short carbonate-soluble pectin chains than soft fruit, and the unripe groups contain higher percentages of wide and long chains than corresponding ripe groups. The nanostructural characteristics of short carbonate-soluble pectin are closely related with firmness of different

cultivars of Chinese cherries[18].

It is suggested that color development in fruits is as a result of anthocyanins, which have high antioxidant capacity and are beneficial for cardiovascular disease[19]. The °Brix levels of apricot could have been influenced by storage temperature and CO_2 concentration as these are reported to interfere with pectin degrading enzymes to produce pectolytic during subsequent ripening of peaches[20].

Unripe fruits are classified as unsuitable for consumption due to their astringent taste. The astringency of the unripe fruits is due to the high tannin content, which decreases with ripening and contributes appreciably to the antioxidant activity of the fruit[21]. The contributions of phenolic compounds to antioxidant activity were much greater than those of vitamin C and carotenoids in both plums and peaches with a strong positive correlation reported between total phenolics and antioxidant activity of nectarines, peaches and plums[22].

Amygdalin is a sugar-containing compound found in small quantities in many fruits and raw nuts. It is also described as vitamin B17 though it is not recognized a vitamin. In a clinical trial, some patients with stomach cancer was found to have reduced tumor size and improved symptoms while receiving amygdalin treatment, however, cancer progression was found after 7 months of completing treatment[23]. Therefore, continuous consumption of peaches and plums could provide health benefit from their accumulated amygdalin content. Nagasawa Hakuho peach has the potentiality to provide high dietary amygdalin compared to Mibaekdo peach and Backaha apricot.

Mibaekdo peach showed potentiality of providing higher amounts of total amino acids in diet than Nagasawa Hakuho, but lower than Japanese apricot did. It is reported that the content of all amino acids changes with developmental stages of fruit with some of the amino acids sharing similar patterns of accumulation, diminution or increment during ripening[24]. The level of expression of all the amino acids in the fruits could be from the activity of glutamine synthetase enzyme which was high in green fruit and decrease during ripening[25]. Malic acid content in unripe peach suggests that peaches could be a good source of malic acid because a higher level of malic acid is found in ripened fruits than in unripe fruits[26].

It can be concluded that the unripe fruit of peach possess a significant biochemical potential of using as a food supplement with potential health benefit for human health and could provide a greater functional benefit in terms of the cancer reducing properties than Backaha apricot.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

Fruit nutrition related studies are found mainly to be focused on ripe fruits. Potentiality of using unripe peach may extend the availability of fresh fruits during fruit growing seasons supplying different nutrients. Exploration of usefulness of unripe peach widens the scope of fruit consumption.

Research frontiers

This study investigates the nutritional value of unripe fruits of two varieties of peach (*Prunus persica*) in comparison to Backaha, a cultivar of Japanese apricot (*Prunus mume*) as a potential food supplement.

Related reports

Malic acid content of unripe Mibaekdo peach was insignificantly different from that of Japanese apricot. Previous studies have reported that malic acid remains relatively higher in unripe fruits. In this research, lower malic acid content in unripe Mibaekdo peach might be due to differences in species as well as variety since unripe Mibaekdo peach contained significantly lower concentration of malic acid than Nagasawa Hakuho peach.

Innovations and breakthroughs

Literature survey shows that little is known about the application of unripe fruits as a food supplement. This study has illustrated the potentiality of using unripe peach fruits as a healthy food supplement.

Applications

Current study depicts that unripe peach fruits possess a significant biochemical potential of using as a food supplement with potential health benefit for human health and could provide a greater functional benefit in terms of the cancer reducing properties than Backaha apricot.

Peer review

This is a valued study in which authors have evaluated the potential usefulness of unripe peach fruits on the basis of nutritive value as well as mechanical and sensory properties. Moreover, authors have depicted a greater

functional benefit of unripe peach fruits in terms of the cancer reducing properties.

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