Variations among Improved Peach Varieties for Fruit Quality and Physicochemical Properties in Ethiopia

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Abstract

Nutritional and functional characteristics of fruits are closely related to their quality and are usually influenced by genotype and ripening stage, as well as by environmental conditions and orchard management practices. The purpose of this research was therefore, to evaluate nutritional profile and selected physicochemical properties of 16 improved and adopted peach varieties in Ethiopia. The results obtained show that improved peach varieties had greater amount of ash (4.3-5.51%), protein (4.34-6.05%),fat (0.097-1.386%) and fiber (2.87-4.611%) than the standard reference (0.263, 1.423,0.427,1.20% respectively), but lower carbohydrate content (84.411-89.90%) than the standard (96.678%). Their mineral content Ca (0.162-0.565 %) Mg (0.037-0.066%), Fe (16.33-159.2%) and Zn (2.43-8.84%) was also higher than that of the standard reference (0.942, 0.051, 0.071, 16.32, 3.213% respectively), while their fruit moisture content was low and had medium TSS content (8.36-14.31%). In general, there was significant variation among sixteen peach varieties for proximate composition and mineral content.

Keywords: Fruit quality, Mineral content and proximate composition

Introduction

Temperate fruits (Apple, Pear, Plum, Peach and Almond etc.) are deciduous types that grow well in temperate climate with chilling temperature. Recently though, because of the low average temperatures, these crops are found to be grown well in the highlands of Ethiopia (Wudineh Getahun *et al*., 2018).

Fruits have long been regarded as a valuable food commodity with potential health benefits, due in part to their natural antioxidant components, which can contribute to decreasing the incidence of cardiovascular and other chronic diseases (Gil, Tomas-Barberan, 2002 and Isabelle and Leea, 2010). It has been revealed that carotenoids and polyphenols such as phenolics, flavonoids, anthocyanins, and phenylpropanoids present in fruits might act as antioxidants or as agents with other therapeutic properties contributing to cardio protective action (Gorinstein *et al.,* 2004).

Nutritional and functional characteristics of fruits are closely related to their quality and are usually influenced by genotype and ripening stage, as well as by environmental conditions and orchard management practices. They are source of soluble carbohydrates such as starches, sugars and fiber pectin, which helps to reduce cholesterol levels in humans by lowering the secretion of insulin (Boyer, and Liu, 2004 and Neda, 2014).

Peach (*Prunus persica L.*) fruits have high economic and nutritional value (Kurz, Carle, Schieber, 2008 and Wolfe *et al.*, 2008). Carbohydrates, organic acids, minerals and dietary fiber are among the major constituents of peach fruit, which contribute to the nutritional quality of both fresh fruits and the juices (Versari *et al.*, 2006). Fully ripened peach fruits, mostly having golden yellowish flesh, are usually sweeter because they exhibit lower acidity. On the other hand, fruits with yellow flesh normally have an acidic flavor together with sweet taste. A peach is exceptionally rich in vitamin A and potassium, in addition to having considerable amounts of other valuable components such as organic acids and natural sugars. These constituents certainly elevate the nutritional status of the peach fruit. With regard to medicinal functions, dietary intake of peach can reduce the generation of ROS (reactive oxygen species) in human blood plasma and provide protection from a number of chronic diseases (Tsantili *et al.*, 2010). Peach fruits have laxative properties and are appropriate to prevent constipation and for the treatment of duodenum ulcers. Phenolic acids, flavonoids, and anthocyanin compounds serve as a major source of potential antioxidants in peach fruit, which may be responsible for these medicinal functions (Rupasinghe *et al*., 2010). The phytochemical contents of fruits are influenced by numerous factors such as climatic conditions, agronomic practices, and varietal differences (Tavarini *et al*., 2008). Moreover, contents of organic acids, carbohydrates and phenolics are not uniformly distributed within different parts of fruits, and most of them are concentrated in the epidermal and sub-epidermal layers of fruit (Mattila *et al.*, 2006) and Manzoor *et al*., 2010). The commercial and domestic uses of large quantity of fruits, especially for the purposes of juice, and/or processed sauces and slice production result in the generation of large quantity of seeds and peel as agro-wastes (Cevallos-Casals *et al*., 2006). Peach fruits are good sources of vitamin C, Vitamin B6 potassium, dietary fiber, folic acid and are cholesterol free. They also contain calcium and iron and have a high protein quality, low sodium and no fat content. They are low in calories with only 30 calories per serving, yet add abundant flavor to a wide variety of foods.

So far, about 16 peach varieties have been released by the Ethiopian Institution of Agriculture Research, Holeta Agriculture Research Center, and these varieties were demonstrated to consumers and are being used for house hold consumption and local markets. However, information on their nutritional profile and quality parameters as affected by genetic and environmental factor, agronomy practices is scanty. The present study was therefore, conducted to determine the nutritional profile and physicochemical properties of improved and adopted sixteen peach varieties in Ethiopia.

Materials and Methods

Field Experiment and Sample Collection

A field experiment was conducted at Holeta agriculture research center (HARC) in the 2018 off season (January- May) using irrigation and soil and nutrition laboratory. The center is found in the Ethiopian highlands, 34 km away from Addis Ababa in the west direction, located at $9^0$4'N longitude and 38^0 30'E latitude and an altitude of 2391 meter above sea level. The mean maximum and minimum temperatures are 22°C and 6°C respectively. The center receives mean total annual rain fall of the area is 1144mm with erratic distribution, having high coefficient of variation in amount. The soil are nitosol and vertisol with mainly clay to clay loam texture and pH of 3.8 -6.2 (Wudineh Getahun *et al*., 2018).

Sample collection

10 to 13 peach fruits sample were collected from each of the 16 varieties unnecessary plant impurities such as gravels and others foreign materials were removed. Depending up on the nature of parameters two types of sample preparation methods were followed. In the first method, samples were ground into fine powder by using automatic gridding machine and sun dried and became ready for physicochemical (Ash, Crude protein, Crude fat, and Crude fiber) analysis. The powdered samples were stored in an air tight bottle at room temperature until further analysis. In the second method cleaned samples ground by gridding machine were filtered and the aliquot liquid or juice was ready for physicochemical analysis total soluble solid (TSS), titrable acidity (TA) pH, Juice volume and juice weight) which was done immediately within less than 8 hours (Kebede *et al*., 2017).

Instruments and chemicals

The instruments and apparatus used in this study were Atomic Absorption spectrophotometer (Agilent, 200 Series AAS) for Mineral elements, Spectro photometer (Janway 6300) for phosphorous and Sulfur determination, pH meter (HI 9017 microprocesser HANNA), Digital soxlet and fiber take FOSS 8000^{TM}. All reagents and chemicals used were of analytical grades and distilled water was used for dilution and preparation of reagents. Traceable to NIST stock solutions, 1000 ppm, were used to prepare a serious of macro and micro mineral elements working standards.

Determination of physical parameters

Total soluble solid (TSS) was determined using refractometer Index using drop of peach juice while titrable acidity (TA) was determined by titrating certain juice volume using NaOH as a titrant and phenolphtein indicator until the pH became 8.2, and pH was determined by using potentiometric method (AOAC,1990). Juice volume and Juice weight were determine by weighing certain mass of peach fruit and preparing the juice and finally weight of 100g per juice volume was measured (AOAC, 1990).

Determination of proximate composition

Total moisture content

The moisture content of powdered peach sample was determined in an oven through drying method (at 105 °C) until constant weight (AACC, 2000). The moisture content in the sample was determined as follows:

$$Moisture\ Content\ (\%) = \frac{Weight\ of\ original\ sample - Weight\ of\ dried\ sample}{Weight\ of\ original\ sample} x\ 100$$

Determination of ash content

About three gram of finely ground dried sample was weighed into a porcelain crucible and incinerated at 550 ^{0} C for 6 hours in an ashing muffle furnace until ash was obtained. The ash was cooled in desiccators and reweighed (AOAC, 1990). The ash content in the sample was determined as follows:

$$Ash\ (\%) = \frac{Weight\ of\ ash}{Weight\ of\ original\ sample} x\ 100$$

Determination of crude protein

The powdered peach sample was tested for crude protein content using the Kjeldahl's method as described by AOAC, which involved protein digestion and distillation.

Protein Digestion: About 2.0 g of the sample was weighed into an ash less filter paper and put into a 250 ml Kjeldahl flask. Then, 1 g of digestion mixture (as catalyst) and 10 ml of 98 % conc. Sulfuric acid were added.

The whole mixture was subjected to heating in the digestion chamber at 380 ^{0}C for 2 hours until transparent residue contents were obtained. Then, it was allowed to cool. After cooling, the digest was transferred into a 100 ml volumetric flask and made up to the mark with distilled water and then distilled using Markham distillation apparatus.

Protein Distillation: Before use, the Markham distillation apparatus was steamed through for 15 min after, which a 100 ml conical flask containing 20 ml of 2 % boric acid and 1 or 2 drops of mixed indicator was placed under the condenser such that the condenser tip was under the liquid. About 5.0 ml of the digest was pipette into the body of the apparatus via a small funnel aperture. The digest was washed down with distilled water followed by addition of 3-4 drops of phenolphthalein and 5 ml of 40 % (W/V) NaOH solution. The digest in the condenser was steamed through until enough ammonium sulfate was collected. The Boric acid plus indicator solution changed color from red to green showing that all the ammonia liberated had been trapped. The solution in the receiving flask was titrated with 0.01N hydrochloric acid upto a purple end point (AOAC, 1990).

Also, a blank was run through along with the sample. After titration, the % nitrogen was calculated using the following:

$$\%\ Nitrogen = \frac{(Vs - Vb)x\ Macid\ x\ 0.01401}{Weight\ of\ original\ sample} x\ 100$$

Where, Vs = Volume (ml) of acid required to titrate sample; Vb = Volume (ml) of acid required to titrate the blank; M acid= Normality of acid concentration (0.1N)
Then, percentage crude protein in the sample was calculated as:
% Nitrogen as % crude protein = % N x F, where, F (conversion factor), is equivalent to 6.25 (AOAC, 1990).

Determination of crude fat

Crude fat was determined using digital FOSS Soxtec^{TM} 8000 through the steps of boiling, rinsing, recovery and auto-shutdown and finally using gravimetric method as follows. About two grams of powdered peach sample was weighed in thimbles and the thimbles insert in the rack i.e the thimbles and extraction cups was loaded, put the solvent recovery flack then add solvent. Select the program and press start for boiling, automatic randell extraction (rinsing), remove the extraction cups and dry in oven at 105 ^{0}C. After solvent recover, cool extraction cups in dissector and the extraction cups were weighed again (Foss Allé, 2014).
The fat content in the sample was calculated using the formula:

$$Fat\ (\%) = \frac{Weight\ of\ fat}{Weight\ of\ original\ sample} x\ 100$$

Determination of crude fiber

About two gram fat free sample of powdered peach was taken into a fiber flask and 100 ml of 0.255 N H_2SO_4 was added. Then the mixture was heated under reflux with heating mantle for one hour. The hot mixture was filtered through a fiber sieve cloth. The difference obtained was thrown off and the residue was returned to the flask to which 100ml of 0.313 M NaOH was added and heated under reflux for another one hour. The mixture was filtered through a fiber sieve cloth and 10ml of acetone was added to dissolve any organic constituent. The residue was washed with 50 ml of hot water twice on the sieve cloth before it was finally transferred in the pre-weighed crucible. The crucible with residue was oven dried at 105°C overnight to drive off moisture. The oven dried crucible containing the residue was cooled in a desiccator and latter weighed (W1) for ashing at 550°C for 4 hours. The crucible containing white and grey ash (free of carbonaceous material) was cooled in desiccators and weighted to obtain W2 (Jurgen Moller, 2014). Then percent crude fiber was calculated as follows:

$$Fiber\ (\%) = \frac{W_1 - W_2}{Weight\ of\ sample}\ x\ 100$$

Where as, W1= Moisture weight W2= weight after ashing

Determination of total carbohydrate

Total carbohydrate content in the peach sample was determined by the difference method. This method involved adding the total values of crude protein, lipid, crude fiber, moisture and ash constituents of the sample and subtracting it from 100. The value obtained was percentage carbohydrate constituent of the sample (AOAC, 1990). Thus:

$$\%Carbohydrate = 100 - (\%Moisture\ +\ \%Crude\ fiber\ +\ \%Protein\ +\ \%Lipid\ +\ \%Ash)$$

Determination of energy value

Energy value of the samples was determined by multiplying the protein content by 4, carbohydrate content by 4 and fat content by 9 (AOAC, 1990).

$$Energy\ Value = (Crude\ protein\ x\ 4)\ +\ (Total\ carbohydrate\ x\ 4)\ +\ (Crude\ fat\ x\ 9)$$

Determination of mineral content

About one gram of finely ground powder sample was weighed into a porcelain crucible and incinerated at 550 ^{0} C for 3 hours in an ashing muffle furnace until ash was obtained. The ash was cooled in desiccators and soaked by 2mL of 37%HCl and 3dops of distilled water. The soaked sample was extracted in 50ml volumetric flask and macro and micro minerals determined using Atomic absorption spectrometer (AAS) (Akinwande, B. and Olatunde, S., 2015).

Macro and micronutrient was calculated as follows:

$$Macronutrient\ Content\ (\%) = \frac{(R - B) * Tv * Df}{Weight\ of\ sample}$$

$$Micronutrient\ (mg/Kg) = \frac{(R - B) * Tv * Df}{Wt * 10{,}000}$$

Whereas, R=Sample Reading by AAS B=blank reading. Tv=total volume extracted after sample ashed Df=dilution factor when extracted sample was above calibration carve. Wt=weight of original sample

Statistical analysis

The data was analyzed statics 10.0 Analytical Software and analysis of variance (ANOVA) for comparison variations among the treatments or peach varieties (Statics 10.0, 2013).

Result and Discussion

Fruit physicochemical properties

The difference among peach varieties was significant ($p \leq 0.05$) for fruit moisture content (MC), titrable acidity (TA), total soluble solid (TSS) and pH. However, there was significant difference between variety Tropic beauty and Florida prince, between Florida star and Tranvilia, 9A-35C and among early grand, 88-18W and 88-22C and between Florida land and 90-19C for moisture content, which showed significant difference among Florida down, Tropic sweet, Mc red and Bony gold (Table 1). This result was in agreement with Getaneh et al (2019).

Similarly, pH of the fresh juice showed no significant difference between variety Early grand, and 9A-35C, between spring crust and Bony gold and among Tranisvilia, Mc red, 90-19C, 88-22C and Florida prince, while the difference between variety Tropic beauty and Florida down was significant (Table1).

All varieties showed significant difference for titrable acidity content. The result of TSS berix(%) in content in the juice showed no significant differences among variety Florida grand, Early grand and 9A-35C and among Tropic beauty, Mc-red and Tropic sweet and 88-22C but variety Florida down had significantly lower value than did the other varieties (Table 1).

Table 1. Fruit Physical Parameters of Peach Varieties

Varieties	% Moisture content fresh	PH	% Titable Acidity	% Total Soluble solid (Berix)
Florida Down	49.650bc	3.487cdef	0.837j	8.363d
Transvilia	46.300def	3.393f	0.930h	13.097b
Florida Grand	43.90ghi	3.533bcde	1.223e	14.07a
Tropic Beauty	48.200cd	3.687abc	0.253n	12.027c
Spring Crust	45.133fgh	3.673abcd	1.570b	13.15b
Early grand	51.16ab	3.737ab	0.353m	14.01a
Bony Gold	47.270de	3.663abcd	1.170f	12.97b
Mc-Red	42.980i	3.437f	1.680a	12.033c
Tropic Sweet	43.157hi	3.457def	0.780k	11.967c
9A-35C	45.63efg	3.7667a	0.887i	13.98a
90-19C	44.130ghi	3.437f	1.263d	13.03b
88-18W	52.380a	3.367f	0.580L	12.69b
88-22C	50.957ab	3.410f	1.320c	12.12c
Florida Prince	48.277cd	3.440f	1.130g	13.08b
Florida Star	46.830def	3.490cdef	0.830j	13.02b
Mean	46.980	3.5269	1.003	12.605
CV	2.70	3.70	2.06	2.61
LSD(p<0.05)	2.1076	0.2173	0.034	0.5467

Where as, CV= Coefficient of variance, LSD= Least significant difference, means followed by the same letter with in a column are not significantly different at $p < 0.05$.

Fruit proximate composition

Results revealed that, except for carbohydrate and energy value, all other parameters proximate composition had significantly ($p \leq 0.05$) higher value than the standard reference which fit the WHO standard (USDA standard, 2018). This result was in agreement with the findings of Calolina et al (2012). Nevertheless there was no significant difference between variety Early grand and Florida star, Transvilia and Bony gold, between Mc-Red and Florida prince and among 9A-35C, 88-18W and Tropic beauty for ash content at $p \leq 0.05$ (Table 2).

There were significant ($p \leq 0.05$) differences among peach varieties, except between Transvilia and Tropic beauty for protein content. Similarly, the difference among peach varieties except, between variety Florida grand, Tropic beauty and Bony gold was significant for fat content. There were also significant ($p \geq 0.05$) differences among the varieties, except among Mc-Red, Tropic beauty, Early grand and 88-12C, for fruit fiber content (Table 2).

Table 2. Fruit Proximate Composition of Peach Varieties

Varieties	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)	EV (cal)
Florida down	2.760j	4.571j	0.097O	2.870n	89.703c	377.97b
Transvilia	4.984b	4.326l	0.116n	3.520k	87.052gh	366.57j
Florida grand	4.300f	4.728h	0.190m	3.190L	87.592d	370.99f
Tropic Beauty	4.397e	4.343 l	0.207L	3.840i	87.213f	368.09i
Spring Crust	3.535i	5.436c	0.283k	4.317e	86.428j	370.01g
Early grand	4.653c	3.629m	0.674e	3.687j	87.356e	370.01g
Bony gold	4.936b	4.534k	0.195Lm	4.265f	86.070k	364.17 l
Mc-Red	3.710h	4.784g	0.510g	3.836i	87.160fg	372.37e
Tropic Sweet	4.049g	5.163e	0.824b	2.989m	86.976h	375.97c
9A-35C	4.343ef	4.821f	0.713d	4.177g	85.945k	369.49h
90-19C	5.388a	4.646i	0.746c	4.611a	84.607m	363.73m
88-18W	4.391ef	5.743b	0.533f	4.167h	85.166 l	368.44i
88-22C	4.499d	5.223d	1.386a	3.678j	85.212 l	374.22d
Florida Prince	3.711h	4.647i	0.493h	4.527b	86.620i	369.51h
Florida Star	4.716c	6.055a	0.473i	4.343d	84.413n	366.13k
Standard	0.263 l	1.423 O	0.427j	1.200O	96.687a	396.23a
Mean	3.9341	4.5317	0.4899	3.7439	87.300	371.74
CV	1.47	0.44	1.88	0.16	0.10	0.06
LSD($p<\leq 0.05$)	0.0963	0.0333	0.0153	0.0097	0.1415	0.3565

EV (cal)- energy value in calories. Figures followed by same letter with in a column are not significantly different at $p \leq 0.05$.

Fruit carbohydrate content also showed ($p \leq 0.05$) significant difference among all the varieties except between variety Transvilia and Tropic beauty and between 88-18W and 88-22C. On the other hands, energy value did not show significant difference between variety Tropic beauty and 88-18W, spring crust and early grand (Table 2).

Fruit mineral content

The results showed that, except for Mg, all improved peach varieties had higher mineral content than the standard reference, but in contrarily to the findings of Maleeha et al. (2012) (Table). Fruit Ca content did not show significant difference between variety Transvilia and Mc-Red, Florida prince and florida star and between Tropic sweet and 9A-35C and among Early grand, 88-18W and 88-22C, but the difference among the remaining varieties was significant (p≤ 0.05) for fruit Ca content.

Similarly, there were no significant differences between Florida star and Transvilia, 90-19C, Tropic sweet and Mc-Red and among Florida down, Florida grand, Tropic beauty, Spiring crust and Florida prince, but significant difference was observed among the standard reference, variety Bony gold and 9A-35C for fruit Mg content (Table 3).

Table 3. Mineral contents of improved peach varieties

Varieties	g/100g		mg/Kg	
	Ca	Mg	Fe	Zn
Florida down	0.169hi	0.049f	116.980d	5.062c
Transvilia	0.297de	0.036i	46.857 l	2.828O
Florida grand	0.565a	0.048f	54.810j	3.287 l
Tropic Beauty	0.233g	0.051ef	113.900de	4.917d
Spring Crust	0.322c	0.047fg	93.810f	5.633b
Early grand	0.158i	0.044gh	159.360a	3.170n
Bony gold	0.396b	0.066b	82.150g	4.605e
Mc-Red	0.308d	0.052de	121.720c	4.475f
Tropic Sweet	0.167hi	0.054de	127.000b	4.182j
9A-35C	0.179h	0.063c	51.667jk	4.358g
90-19C	0.259f	0.055d	50.910k	2.425p
88-18W	0.161i	0.042h	112.610e	4.915d
88-22C	0.162i	0.043h	70.233h	4.280h
Florida Prince	0.293e	0.047fg	64.533i	3.552k
Florida Star	0.286e	0.037i	66.717i	8.840a
Standard	0.051j	0.071a	16.313m	3.213m
Mean	0.2452	0.0501	84.883	4.3515
CV	3.41	4.13	2.40	0.55
LSD(p≤0.05)	0.0139	0.003	3.3797	0.0396

Figures followed by same letter(s) are not significantly different p>0.05.

All varieties exhibited relatively higher values than the standard reference and no significant difference between variety Florida down and tropic beauty, Spring crust and Florida star and between Florida grand and 9A-35C, but difference among the other varieties was significant for Fe content (Table 3). Similarly, there was significant difference among peach varieties for Zn content and all the improved varieties had greater Zn content than the standard reference, except for variety Transvilia, 9A-35C and Early grand (USDA standard, 2018) (Table 3).

Conclusions

Results of the present study revealed low moisture content and high quality and high TA and TSS content of fresh peach juice which varied between 0.253 and 1.680%, and 8.363 and 13.980%, respectively. It was observed that improved peach varieties had greater amount of proximate nutrient values and mineral contents than the standard reference including that the varieties fall within the WHO for most of the quality parameters, quality except for carbohydrate and Calcium content and energy value. Nevertheless, further studies are required for bioactive and antibiotic compounds to come up with conclusive remarks about the varieties.

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