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ORIGINAL PAPER

Effects of Baking and Boiling on the Nutritional and Antioxidant Properties of Sweet Potato [*Ipomoea batatas* (L.) Lam.] Cultivars

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Abstract The effects of baking and boiling on the nutritional and antioxidant properties of three sweet potato cultivars (Beniazuma, Koganesengan, Kotobuki) cultivated in Turkey were investigated. The samples were analyzed for proximate composition, total phenolic content, ascorbic acid, β-carotene, antiradical activity, and free sugars. The dry matter, protein, and starch contents of the sweet potatoes were significantly changed by the treatments while the ash and crude fiber contents did not differ as significantly. The β-carotene contents of baked and boiled sweet potatoes were lower than those of fresh sweet potatoes; however, the total phenolic and ascorbic acid contents of the baked and boiled sweet potatoes were higher than those of the fresh samples. Generally, the antiradical activity of the sweet potatoes increased with the treatments. Sucrose, glucose, and fructose were quantified as free sugars in all fresh sweet potatoes; however, maltose was determined in the treated samples. In terms of the analyzed parameters, there were no explicit differences among the sweet potato cultivars.

Keywords Antioxidant · Baking · Boiling · *Ipomoea batatas* · Sugar · Sweet potato

Abbreviations

DPPH	2,2-diphenyl-1-picrylhydrazyl
GAE	Gallic acid equivalent
HPLC	High performance liquid chromatography
IC_{50}	50% inhibitory concentration
RAE	Retinol activity equivalent
TPC	Total phenolic content
TUBITAK	Scientific and Technological Research Council of Turkey

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Introduction

The sweet potato [*Ipomoea batatas* (L.) Lam.] is one of the most widely consumed tubers in many cuisines [1]. It is rich in dietary fiber, minerals, and vitamins and antioxidants such as phenolics, ascorbic acid (vitamin C), and carotenoids, of which almost all are trans-β-carotene (provitamin A) [2–5].

Sweet potato is usually cooked by baking, boiling, microwaving, steaming, or frying. These cooking processes would certainly bring about a number of changes in the physical characteristics and chemical composition of sweet potatoes [6–8]. For instance, ascorbic acid and β-carotene of sweet potato are changed by different heat treatments [3, 4, 9]. Generally, the total phenolic content of sweet potatoes increases, on the other hand, some phenolic derivatives such as caffeic acids are decreased by heat treatment [8, 10]. In relation to the variation of these constituents, the antioxidant activity of sweet potatoes also shows similar variation during thermal processes [7]. Starch and sugar contents have also been reported to be changed by cooking procedures as starch decreases during the steaming process, yielding maltose [11].

Generally, all these variations in sweet potato may be related not only to the cooking processes, but also to the cultivar and cultivation procedure of the product. A few reports have been published about the influence of cooking

methods on different cultivars of sweet potato with respect to functional and nutritional compounds [7, 8, 12]. As far as we know, there is no information available about the influence of baking and boiling treatments on the nutritional constituents and antioxidant properties of the sweet potato cultivars Beniazuma, Koganesengan, and Kotobuki. Only one study related to changes in the sugar composition of Beniazuma and Koganesengan cultivars through steaming was found [13].

The aim of the present study was to investigate the nutritional constituents and antioxidant properties of the Beniazuma, Koganesengan, and Kotobuki cultivars of sweet potato grown in the Mediterranean region of Turkey. In addition, the influence of baking and boiling treatments, which are commonly applied to different types of potatoes, on the nutritional and bioactive constituents of these cultivars was also determined.

Material and Methods

Materials

In this research, about 50 kg of sweet potato [*Ipomoea batatas* (L.) Lam.] tubers of each cultivar (Beniazuma, Koganesengan, and Kotobuki) were randomly harvested in September 2009 from the field at the Agricultural Biotechnology Sciences Research and Application Centre, Akdeniz University, Antalya, Turkey. One part of the harvested tubers was used for preliminary cooking tests. The remaining part of the tubers was stored at 10 °C and 85% relative humidity during the preliminary tests (about two months). For the main experiments, 25 kg of the stored sweet potatoes were sorted by sense of proportion into similar sizes corresponding to weights of 260–302 g (Beniazuma), 230–268 g (Koganesengan), and 145–190 g (Kotobuki) for each cultivar. Two-thirds of the sorted samples were used for boiling and baking treatments and the remaining part was used for fresh sweet potato analyses.

Cooking Procedures

Baking The sorted sweet potato tubers were baked using slight modifications of Wang and Kays's method [6]. The tubers of each cultivar were washed with running tap water and individually wrapped with aluminum foil. They were put in a pre-conditioned electric oven (Fimak Electrical Deck Oven, EKF 60, Konya, Turkey) at 100 °C, the temperature was steadily raised to 200 °C (within 27–29 min), and then the samples were kept at this temperature until they attained a desirable taste and texture. The taste and texture of the baked potatoes were preliminarily tested using sensorial evaluation to decide whether they were equally cooked and the optimum baking times of the tubers of the Kotobuki, Koganesengan, and Beniazuma cultivars were selected as 80, 85, and 90 min, respectively.

Boiling The sorted tubers of Kotobuki, Koganesengan, and Beniazuma cultivars were boiled by submerging them in boiling water (95–100 °C) in a stainless steel pot for 30, 35, and 40 min, respectively [6]. The boiling was maintained using a hot plate. The boiling time for the tubers of each cultivar was again determined by preliminary tests with sensorial evaluation.

Sample Preparation

After the treatments, the samples were placed on a bench at room temperature to cool down. The fresh and treated samples were peeled and chopped into small pieces. They were separated into two parts. One of these parts was used for proximate composition and the other part was dried with a freeze dryer (Operon FDU & FDB type, Gyeonggi-do, Korea) until the final moisture content was less than 3%. They were all stored at −18 °C until the analyses were carried out. Just before the analyses, the freeze-dried samples were crushed with a blender (Beko BKK-2155 Maxi Hand Blender, Ankara, Turkey) and passed through a 35-mesh sieve (Retsch, Haan, Germany).

Analyses

Proximate Composition Analyses The dry matter, crude fiber, ash, and starch contents of the samples were determined by official methods [14]. The crude protein content of the samples was calculated by converting the nitrogen content determined using the Kjeldahl method (N×6.25).

Total Phenolic Content (TPC) Analysis The powdered samples were extracted according to the method used by Padda and Picha [7]. Samples of 1±0.001 g were placed into a 50 ml centrifuge tube, and 20 ml of aqueous methanol solution (80%) was added. The tubes were heated in a water bath at 80 °C for 10 min. After manually shaking for 30 s, the tubes were cooled down to room temperature and centrifuged at 4,500 *g* for 20 min. The supernatants were transferred to 25 ml volumetric flasks and the volumes were adjusted with the extraction solution. The final solution of each sample was used in the TPC analysis.

The TPC analyses were accomplished using the method developed by Skerget et al. [15]. For this purpose, 0.5 ml of the extract was treated with 2.5 ml of 0.1 N Folin-Ciocalteu reagent and 2 ml of Na_2CO_3 (75 g/l). Then, the mixture was incubated at 50 °C for 5 min and immediately cooled. The absorbance of the final solution was recorded with a

spectrophotometer (Shimadzu UV–vis 160A, Tokyo, Japan) at a wavelength of 760 nm with respect to the blank solution. The results were expressed as gallic acid equivalents (mg GAE/g dw).

Ascorbic Acid Analysis The ascorbic acid analysis of the samples was carried out by the method used by Huang et al. [12]. The sample (0.5 g) was extracted with 10 ml of metaphosphoric acid solution (1%, pH was adjusted to 1.86 with 0.1 N HCl) in centrifuge tubes by shaking (200 rpm) in a water bath (GFL 1092, Burgwedel, Germany) at room temperature for 30 min. Then, the slurry was centrifuged at 3,000 *g* and 4 °C for 15 min. One milliliter of supernatant was added into 9 ml of dye solution (15 mg 2.6-dichlorophenol indophenol/l) and its absorbance was measured at 515 nm within 15 s after shaking. The calibration curve of authentic L-ascorbic acid was used to determine the ascorbic acid content of the samples. The results were expressed as milligrams of ascorbic acid/100 g dw.

β-carotene Analysis The β-carotene content of the samples was determined according to Ahmed et al. [3]. The samples (1 g) were extracted in 10 ml of a mixture of hexane and acetone (7:3) and the extracts were centrifuged at 1,834 g and 25 °C for 3 min and filtered through filter paper (Whatman No. 1). The residue was re-extracted similarly until it became colorless. The filtrates were combined in a separatory funnel and washed with 50 ml of distilled water several times to remove the acetone. Then, the water phase was discarded, a pinch of Na_2SO_4 was added into the hexane phase as a desiccant, and the hexane phase was collected in a volumetric flask. The volume was adjusted with hexane and its absorbance was recorded with a spectrophotometer (Shimadzu UV–vis 160A, Tokyo, Japan) at 450 nm with respect to hexane. The results were expressed as β-carotene equivalents by using concentration *versus* absorbance plots of β-carotene.

The β-carotene results were also converted into retinol activity equivalent (RAE) values on a wet basis, representing digestible provitamin A, by using the mathematical expression for RAE (μg RAE/100 g=μg β-carotene/12) [16].

Antiradical Activity Analysis The antiradical activity of the samples was determined by the DPPH radical scavenging activity assay by using modified methods used by Maisuthisakul et al. [17]. One hundred microliters of each diluted extract (prepared for TPC analysis) was added into 4 ml of freshly prepared DPPH (2,2 Diphenyl-1-picryhydrazyl radical) solution (6×10^{-5} M in MeOH). Then the mixtures were shaken and placed in the dark at room temperature for 30 min. Absorbances (A_s) of the final solutions were recorded at 516 nm using a spectrophotometer (Shimadzu UV–vis 160A, Tokyo, Japan) with respect to blank DPPH solutions (A_c). The measurements were performed in triplicate. The inhibition percentage of the DPPH radical was calculated by the following equation:

$$\text{Inhibition } (\%) = [(A_c - A_s)/A_c] \times 100$$

The extract concentration providing 50% inhibition (IC_{50}) was calculated by plotting the concentration *versus* inhibition. Using the same procedure, the IC_{50} of Trolox solution was also determined for the extracts.

Free Sugar Analysis The free sugar composition of the samples was determined according to the method used by Rocculi et al. [18] with some minor modifications. A sample of 2 g was extracted with 10 ml of distilled water in a centrifuge tube by using a shaking water bath at 40 °C and 150 rpm for 20 min. Then, the slurry was centrifuged at 3,000 *g* for 15 min at 25 °C, filtered through a 0.45 μm membrane filter, and injected into the HPLC system.

The chromatographic separation was performed on a solvent delivery system (20AD, Shimadzu, Tokyo, Japan) coupled with an auto-sampler (SIL-20A Prominence, Shimadzu, Tokyo, Japan), column (Supelcosil LC-NH_2, 25 cm×4.6 mm, 5 μm), and refractive index detector (RID-10A, Shimadzu, Tokyo, Japan), which were controlled by LC solution software. Each run was carried out by isocratic elution performed on the column, which was maintained at 40 °C by using a column oven (Varian Mistral, CA) for 20 min. The mobile phase was an acetonitrile–water (75:25) mixture at a flow rate of 0.75 $ml.min^{-1}$. The samples were analyzed by triplicate injection with a volume of 20 μl.

The peaks in every sample chromatogram were identified by matching the retention time of authentic standards and they were confirmed by the spiking of authentic standards into the samples. Peaks were externally quantified by using the calibration curve of the authentic standards.

Statistical Analysis The research was carried out using a factorial design. The treatments were duplicated and analyses were carried out using three replicates. Analysis of data was performed using the Statistical Analysis System software (SAS for windows, version 7) to determine the effects of the dependent variables. Mean values were compared using Duncan's Multiple Range Test at the 5% level.

Results and Discussion

Proximate Composition of the Sweet Potatoes The proximate compositions of the fresh, baked, and boiled sweet

potato samples are shown in Table 1. The dry matter content of the samples ranged between 31.07% and 40.65%, and showed significant ($P<0.05$) differences between the cultivars and the treatments. Generally, the treated samples had a higher dry matter content than the fresh samples. These differences may be related with the destruction of the cells, which leads to easy removal of water from the hot surfaces of the samples. These results coincided with the findings of Takahata et al. [13].

The ash content of the samples was in the range of 2.13–2.62% and the crude fiber content was 2.11–2.76%. In previous studies on different sweet potato varieties, the ash and crude fiber contents were reported to be in the ranges of 1.76–4.09% and 1.43–4.40%, respectively [2, 19], which are generally in agreement with the present results.

The protein content of the present samples ranged between 3.54% and 5.08%. Other researchers reported that the protein content of different sweet potato varieties ranged between 3.53% and 8.87% [2, 19]. The differences in protein contents are also considered to be related to the varieties. Out of the present cultivars, the protein content of Beniazuma was significantly ($P<0.05$) higher than those of the other samples. It is an interesting point that the protein content of all samples decreased significantly ($P<0.05$) during baking, while it did not change during boiling. Considering the different durations and temperatures of the treatments, the slight but significant decreases in protein contents of the baked sweet potatoes might be due to a non-enzymatic browning reaction which may have been stimulated by high temperature treatment.

The main constituent of all the sweet potato samples was found to be starch, whose values ranged between 49.22% and 64.89% and showed significant ($P<0.05$) differences between the cultivars. Generally, the starch content of Koganesengan was slightly higher than those of the other cultivars.

As to the treatments, the boiling process led to significant ($P<0.05$) degradation in starch, especially in Beniazuma (22.97%), followed by Koganesengan (18.14%) and Kotobuki (11.50%). These reductions can be associated with the gelatinization effect, which breaks down the intermolecular bonds of starch molecules in the presence of water at high temperature [20]. It has also been reported that starch is hydrolyzed by thermal treatments in water enabling media [21]. Considering that the hydrolyzing enzymes would be inactivated in boiling treatments, the present starch degradation might also be related with acidic hydrolysis.

Total Phenolic Content (TPC) The TPC of the samples ranged between 0.93 and 1.98 mg GAE/g dw. Figure 1 illustrates that the TPC of the samples increased with both baking and boiling treatments. The highest TPC was found in boiled samples for all cultivars. Only in Beniazuma, there was no significant difference between the boiled and baked samples. A similar increment in the TPC of sweet potato was also reported in a previous study [10]. The authors explained this explicit increment in the TPC as the liberation of phenolics by hydrolysis of the glycoside bonds during the treatments and induction of TPC oxidation in fresh samples through the catalytic activity of the polyphenoloxidase enzyme. However, a few studies on different sweet potato cultivars have reported that heat treatment did not significantly change their TPC [7, 10].

Ascorbic Acid Figure 2 illustrates the ascorbic acid values of the sweet potato samples. Generally, the mean ascorbic acid contents of the fresh, boiled, and baked sweet potatoes were in the ranges of 14.07–20.18, 24.77–37.15, and 19.43–27.88 mg/100 g dw, respectively, which were equivalent to 4.71–6.81, 9.33–13.43, and 7.90–10.62 mg/

Table 1 Proximate composition of fresh and cooked sweet potatoes (g/100 g dry weight)

Cultivars	Treatments	Dry matter*	Ash	Crude fiber	Protein	Starch
Beniazuma	Fresh	33.76 ± 0.17^{bA}	2.15 ± 0.08^{bB}	2.33 ± 0.10^{baA}	5.08 ± 0.05^{aA}	63.90 ± 0.11^{aB}
	Boiled	36.15 ± 0.47^{aB}	2.31 ± 0.05^{baB}	2.45 ± 0.03^{aB}	5.03 ± 0.04^{aA}	49.22 ± 0.02^{cC}
	Baked	38.10 ± 0.64^{aB}	2.44 ± 0.06^{aA}	2.11 ± 0.04^{bB}	4.56 ± 0.05^{bA}	55.80 ± 0.18^{bB}
Koganesengan	Fresh	33.50 ± 0.88^{bBA}	2.13 ± 0.01^{aB}	2.65 ± 0.08^{aA}	4.29 ± 0.02^{aC}	64.89 ± 0.04^{aA}
	Boiled	37.65 ± 1.51^{baA}	2.19 ± 0.08^{aB}	2.70 ± 0.06^{aA}	4.36 ± 0.12^{aB}	57.43 ± 0.00^{cA}
	Baked	40.65 ± 0.51^{aA}	2.31 ± 0.11^{aA}	2.64 ± 0.02^{aA}	3.54 ± 0.01^{bB}	60.22 ± 0.03^{bA}
Kotobuki	Fresh	31.07 ± 0.32^{bB}	2.54 ± 0.03^{aA}	2.62 ± 0.10^{aA}	4.64 ± 0.06^{aB}	64.35 ± 0.26^{aBA}
	Boiled	33.00 ± 0.67^{bB}	2.60 ± 0.02^{aA}	2.76 ± 0.02^{aA}	4.69 ± 0.13^{aBA}	52.68 ± 0.29^{cB}
	Baked	36.55 ± 0.28^{aB}	2.62 ± 0.06^{aA}	2.59 ± 0.09^{aA}	3.67 ± 0.08^{bB}	59.99 ± 0.91^{bA}

* g/100 g wet basis. Results are means±standard error ($n=2$). Values within a column with different superscript lowercase letters are significantly ($P<0.05$) different between the treatments for each cultivar. Values with different superscript capital letters are significantly ($P<0.05$) different between the cultivars with the same treatments

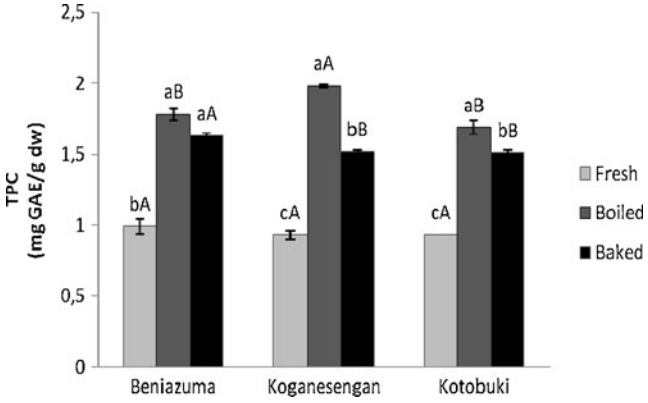

Fig. 1 Total phenolic content of fresh and cooked sweet potatoes [the results are the means ± standard error (n=2); the values with different lowercase letters are significantly (P<0.05) different between treatments in the same cultivar and the values with different capital letters are significantly (P<0.05) different between the cultivars with the same treatments]

100 g sweet potatoes in wet basis. Between the cultivars studied, the Beniazuma samples had the highest ascorbic acid content after both treatments. It is known that ascorbic acid is a heat sensitive bioactive food component [22, 23]. The current study revealed the opposite effect, in which could be expected, in that the ascorbic acid contents of the sweet potatoes were higher in both baked and especially boiled sweet potatoes than in the fresh samples. The lower ascorbic acid amount in the fresh sweet potatoes may be related to the presence of a naturally occurring active oxidizing enzyme such as ascorbic acid oxidase, which would likely be active in fresh samples during sample preparation. As a matter of fact, ascorbic acid oxidase activity has been reported to be high in sweet potato [24]. This interesting finding is very similar to that of a previous study by Huang et al. [12], where the authors explained that this difference in the ascorbic acid content of fresh and heat treated samples could be attributed to the pre-treatment and storage procedures applied prior to the measurements. Another explanation given by the authors is that degradation of anthocyanins during treatment may have affected the ascorbic acid analyses. However, this hypothesis would not support our case since none of our samples were purple.

β-carotene In this study, the β-carotene levels of the samples were determined as equivalents and the results were also calculated as RAEs (Table 2). According to the results, the highest β-carotene content was present in Beniazuma, followed by Kotobuki and Koganesengan. As seen in Table 2, the β-carotene contents of the Beniazuma, Koganesengan, and Kotobuki cultivars were in the ranges of 10.07–15.63, 1.15–5.63, and 6.62–11.38 mg/100 g dw, respectively. These β-carotene values correspond with RAE values in the ranges of 260.5–439.8, 38.9–157.2 and 201.6–294.7 μg/100 g wb, respectively.

Both the boiling and baking treatments resulted in a significant (P<0.05) reduction in the β-carotene content and therefore in the RAE values of the sweet potato samples. In particular, the baking process caused the highest reduction in the β-carotene content of the Beniazuma, Koganesengan, and Kotobuki cultivars (35.57%, 79.57%, and 41.83%, respectively). However, boiling caused a lower reduction (19.13%, 41.74%, and 21.27%) in the β-carotene content in the same cultivars. As explained by Dutta et al. [25], the greater reduction in β-carotene content of baked sweet potatoes may be due to the oxidative and non-oxidative changes at higher temperatures such as *cis–trans* isomerization and epoxide formation. In previous studies, similar reductions have been determined in the β-carotene content of different sweet potato cultivars with boiling treatment [4, 26].

Antiradical Activity Antiradical activity of the samples was evaluated in DPPH radical scavenging activity assay using IC_{50}. Figure 3 illustrates the IC_{50} values of the samples. Out of all the samples, the IC_{50} values of the fresh Koganesengan and Kotobuki sweet potatoes were found to be the highest, without any significant differences between them, which mean that they had the lowest antiradical activity. However, in comparison to the other cultivars, the fresh samples of Beniazuma had a higher antiradical activity. The samples which had high phenolic and ascorbic acid contents also showed high antiradical activity (Fig. 3). A similar relationship of phenolic and ascorbic acid with antiradical activity was also reported in previous researches [27, 28]. However, β-carotene does not show any DPPH

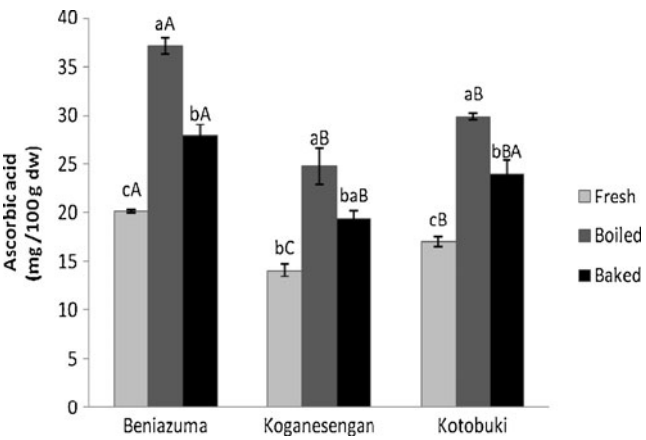

Fig. 2 Ascorbic acid content of fresh and cooked sweet potatoes [the results are means ± standard error (n=2); the values with different lowercase letters are significantly (P<0.05) different between the treatments in the same cultivar and the values with different capital letters are significantly (P<0.05) different between the cultivars with the same treatments]

Table 2 β-carotene content and RAE values of fresh and cooked sweet potatoes

Treatments	β-carotene content (mg/100 g dry weight)			RAE values (μg/100 g wet basis)		
	Beniazuma	Koganesengan	Kotobuki	Beniazuma	Koganesengan	Kotobuki
Fresh	15.63 ± 0.38^{aA}	5.63 ± 0.28^{aC}	11.38 ± 0.59^{aB}	439.8 ± 8.7^{aA}	169.5 ± 6.2^{aC}	361.6 ± 24.8^{aB}
Boiled	12.64 ± 0.59^{bA}	3.28 ± 0.52^{bC}	8.96 ± 0.51^{baB}	353.1 ± 25.5^{bA}	102.3 ± 12.2^{bB}	303.6 ± 20.9^{baA}
Baked	10.07 ± 0.54^{cA}	1.15 ± 0.18^{cC}	6.62 ± 0.91^{bB}	260.5 ± 11.2^{cA}	31.6 ± 5.5^{cB}	201.6 ± 26.0^{bA}

Results are means ± standard error (n=2). Values within a column with different superscript lowercase letters are significantly (P<0.05) different between the treatments for each cultivar. Values in a row with different superscript capital letters are significantly (P<0.05) different between the cultivars with each treatment.

scavenging activity [29]. Generally, the IC_{50} values of the samples decreased during the treatments. These reductions in the IC_{50} values in Koganesengan and Kotobuki were determined to be significant (P<0.05). Yang et al. [30] also reported that the antiradical activity of sweet potatoes was enhanced by heat treatment via the formation of phenolic compounds. However, it is interesting that the IC_{50} value of the Beniazuma samples did not change significantly with the treatments. Regarding the overall results, this phenomenon of Beniazuma might be associated with different polyphenolic components which might have different sensitivity to heat treatment. As a matter of fact, the IC_{50} values of fresh Beniazuma samples were significantly different from those of the other cultivars, although their TPC values were not (Figs. 1 and 3).

Free Sugars The free sugar contents of the sweet potato cultivars are given in Table 3. The main sugars of fresh sweet potato samples are sucrose, glucose, and fructose. Out of these sugars, sucrose was predominant. After treatment, however, a substantial amount of maltose (48.13–122.83 mg/g dw) was also detected in all the samples. When these results were evaluated together with the starch results, a reverse relationship could be clearly recognized (Tables 1 and 3). Hence, it can be concluded that the liberation of maltose after the treatments is closely related to the thermal hydrolysis of starch. A similar explanation has been stated in a previous study to determine the level of maltose after thermally treating sweet potato [13]. Concerning glucose and fructose, they were generally reduced by the treatments, especially the baking treatment, except in the Kotobuki cultivar.

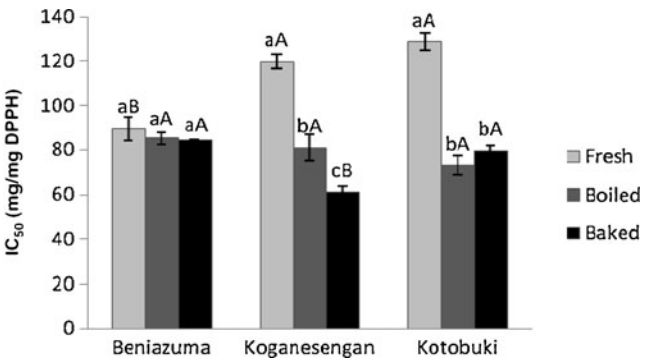

Fig. 3 Free radical scavenging activity of fresh and cooked sweet potatoes [for Trolox IC_{50}=0.16±0.01 mg/mg DPPH; the results are means ± standard error (n=2); the values with different letters are significantly (P<0.05) different between the treatments in the same cultivar and the values with different capital letters are significantly (P<0.05) different between the cultivars with the same treatments]

Conclusions

Interestingly, the results showed that the ascorbic acid and total phenolic contents and the antiradical activity of the treated samples were generally higher than those of the fresh samples, whereas the starch, β-carotene, and sugar levels of some samples notably decreased. Considering the results obtained for the current cultivars, from a nutritional standpoint, boiling rather than baking can be recommended

Table 3 Free sugars content of fresh and cooked sweet potatoes

Free sugars content (mg/g dry weight)				
Sugars	Treatments	Beniazuma	Koganesengan	Kotobuki
Glucose	Fresh	4.36 ± 0.02^{aB}	2.73 ± 0.01^{aC}	4.68 ± 0.01^{bA}
	Boiled	3.30 ± 0.06^{bB}	1.34 ± 0.02^{cC}	3.94 ± 0.01^{cA}
	Baked	1.76 ± 0.05^{cB}	1.72 ± 0.01^{bB}	4.90 ± 0.05^{aA}
Fructose	Fresh	4.00 ± 0.34^{aA}	1.43 ± 0.02^{aB}	3.51 ± 0.05^{bA}
	Boiled	1.99 ± 0.01^{bB}	1.42 ± 0.01^{aC}	3.75 ± 0.05^{aA}
	Baked	1.55 ± 0.01^{bB}	1.24 ± 0.02^{bC}	3.38 ± 0.06^{bA}
Sucrose	Fresh	59.97 ± 0.09^{baA}	58.06 ± 1.31^{bA}	56.94 ± 0.58^{bA}
	Boiled	61.50 ± 0.76^{aA}	53.71 ± 1.44^{bB}	48.99 ± 1.44^{cB}
	Baked	55.52 ± 1.69^{bB}	64.36 ± 0.05^{aA}	61.86 ± 0.33^{aA}
Maltose	Fresh	$n.d.^{cA}$	$n.d.^{cA}$	$n.d.^{cA}$
	Boiled	122.83 ± 2.16^{aA}	48.13 ± 1.12^{bC}	89.94 ± 1.14^{aB}
	Baked	48.52 ± 0.50^{bB}	56.27 ± 0.85^{aA}	48.98 ± 0.68^{bB}

n.d: not detected. Results are means ± standard error (n=2). Values within a column with different superscript lowercase letters are significantly different at P<0.05. Values in a row with different superscript capital letters are significantly (P<0.05) different between the cultivars.

for sweet potato cooking. In terms of β-carotene and ascorbic acid contents, Beniazuma was found to be preferable to the other cultivars.

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