



Acceptability of beetroot pre-processed under different cooking methods

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ABSTRACT: This study aimed to evaluate the acceptability of beet subjected to four heat treatments (steam cooking, cooking in a pressure cooker, cooking in the oven and immersion in water) and three different pre-preparation methods (whole unpeeled, whole and manually peeled, and peeled and sliced in a food processor). The following sensory attributes were analyzed: appearance, odor, texture, flavor and overall evaluation through affective test using a hedonic scale with nine points. Sensory analysis was performed with unselected and untrained tasters of both sexes, aged over 18 years, 60 tasters for each day of analysis. The best sensory acceptance in the opinion of women was attributed for sliced and steamed beets and the worst for sliced beets cooked in pressure cooker, while for men, the most accepted were whole unpeeled beets cooked in pressure cooker and sliced steamed beets, and the less accepted were sliced beets cooked through immersion in water. For both sexes, the most and less accepted were sliced steamed beets and sliced beets cooked in the oven and whole unpeeled beets cooked in the oven. The biggest losses of color occurred in sliced beets cooked in pressure cooker and immersed in water.

Keywords: *Beta vulgaris* L., heat treatment, pre-preparation, sensory analysis.

Aceitabilidade de beterrabas pré-processadas submetidas a diferentes métodos de cocção

RESUMO: Objetivou-se avaliar a aceitabilidade da beterraba submetida a quatro tratamentos térmicos (cocção a vapor, cocção em panela de pressão, cocção no forno e na água em imersão) e em três diferentes pré-preparos (beterrabas inteiras com casca, beterrabas inteiras descascadas manualmente e beterrabas descascadas e fatiadas em processador de alimentos). Foram analisados os seguintes atributos sensoriais: aparência, odor, textura, sabor e avaliação geral através de teste afetivo utilizando escala hedônica estruturada de nove pontos. A análise sensorial foi realizada com provadores não selecionados e não treinados, de ambos os sexos, com idade acima de 18 anos, sendo 60 provadores para cada dia de análise. A melhor e pior aceitação sensorial, para o sexo feminino, foi das beterrabas fatiadas cozidas no vapor e as fatiadas na pressão, enquanto que para o sexo masculino, as mais aceitas foram as inteiras com cascas cozidas na panela de pressão e as fatiadas no vapor, e a menos aceitas foram as fatiadas cozidas em imersão em água. Para ambos os sexos, as mais e menos aceitas foram as fatiadas no vapor e no forno e as inteiras com casca no forno. As maiores perdas na coloração foram das beterrabas fatiadas cozidas na pressão e imersas em água.

Palavras-chave: *Beta vulgaris* L., tratamento térmico, pré-preparo, análise sensorial.

1. INTRODUCTION

The beet has a large amount of sugars, minerals and vitamins A, B1, B2 and C, among others. The coloring aspect is the result of a pigment named betalains (ARAÚJO FILHO et al., 2011). It also has phenolic compounds, flavonoids and anthocyanins, that are important antioxidant compounds for the human organism, serving for very important biological functions such as preventing cancers and cardiovascular diseases.

The interest in this vegetable has increased, both for its fresh consumption and for processing in industries (SOUZA; RESENDE, 2003; MARQUES et al., 2010).

Over the past decade, increasing demand for beet has been observed, both for use in children's food canning industries

and for fresh consumption (MARQUES et al., 2010). There is also high consumption in the form of minimally processed and ready salads, which are increasingly present in supermarkets in major centers (ECHER et al., 2007).

Vegetables are often consumed in raw form. However, there are situations in which the cooking is required or preferred. In this case, the content of nutrients may change (CAMPOS et al., 2008). Cooking vegetables can be made through different ways and at different times in boiling water, steam or dry heat, depending on the type of equipment employed, such as conventional stove and oven.

Another way is to consume vegetables in its cooked form, which results in increased palatability, aroma and facilitates mastication. Yet, cooking may cause changes in their nutritional

composition. These changes vary according to the time and the type of cooking and its form of preparation (SCHEIBLER et al., 2010; CAMPOS et al., 2008).

Different cooking methods and the way of preparation (peeled or unpeeled, whole or sliced) interfere with the nutritional quality of foods (PIGOLI et al., 2014, DAIUTO et al., 2015, DAIUTO et al., 2012). Besides affecting the retention of nutrients, such methods may also influence the acceptability of the product after processing. According to Pedrão; Coró (1999), the acceptability of food products depends on their appearance, or the color, shape and packaging, followed by the aroma, flavor and texture. Sensory analysis works synchronously with these sensory attributes, seeking to meet the needs of consumers.

The objective of this work was to evaluate the acceptability of beet prepared through different cooking (steam, pressure, oven and water) and pre-preparation (peeled, unpeeled, sliced) methods.

2. MATERIALS AND METHODS

Beets from the Borus hybrid cultivar produced at Fazenda Dalbon, located in São José do Rio Pardo/SP, in the geographic coordinates 21°35'45" S and 46°53'23" W, in May 2014, were used in the study. After harvest, beets were immediately transported through road transportation for the Nutrition and Dietetics Laboratory of the Institute of Biosciences of São Paulo State University "Julio de Mesquita Filho", Botucatu, SP. Subsequently, beets were selected seeking to homogenize the batch regarding size, color and absence of injuries and defects. Beets were then washed in running water to remove dirt.

Pre-tests were performed to establish the correct time for each cooking method and the form of preparation, aiming to make the vegetable "*al dente*" (COPETTI, OLIVEIRA, KIRINUS, 2010), which is found in Table 1.

Four heat treatments were carried out: steam cooking, cooking in the pressure cooker, cooking in the oven and water immersion. These were carried out with three different pre-preparations: whole unpeeled, whole and manually peeled, and peeled and sliced in a stainless food processor. For each type of cooking, eight beets were used, totaling an average weight of two kilograms per treatment. Stainless steel pans with a capacity of 2 L were used in the steam cooking cycles.

The amount of 1.6 L of water and two cooked beets were used in each pot. In the pressure treatments, a commercial pressure cooker with capacity of 15 L were used, and eight

Table 1. Cooking times for each treatment recommended by the author of this work.

Tabela 1. Tempos de cocção para cada tratamento preconizado pelo autor do presente trabalho.

Treatments	Cooking time
Whole unpeeled steam	1h 18min
Whole unpeeled pressure	30min
Whole unpeeled oven	3h
Whole unpeeled water	1h 5min
Whole shelled steam	56min
Whole shelled pressure	22min
Whole shelled oven	1h 57min
Whole shelled water	51min
Toast shelled steam	30min
Toast shelled pressure	10min
Toast shelled oven	40min
Toast shelled water	24min

beets were placed in 4.5 L of water in each pre-preparation. In the oven, a combination of oven dry heat at 200°C was used. Beets were wrapped in aluminum foil to prevent excessive dehydration and to make them evenly cooked.

For treatments of immersion, an aluminum pan with lid and capacity of 10 L was used. For whole peeled and unpeeled beets, 5 L of water were used, and for sliced beets, 3 L of water were used.

2.1. Sensory analysis

The test was performed in order to choose the best form of pre-preparation and cooking of beet, among all treatments.

Sensory analysis was carried out during three days, one day for pre-preparation (whole unpeeled, whole peeled and sliced beets). The tasters received a sample from each treatment (steam, pressure, oven and water) at room temperature. The sample was served in plastic cup, with an average weight of 50 g, accompanied by drinking water for tasting. Beets were analyzed for the following attributes: appearance, odor, texture, flavor and overall evaluation through affective test - acceptance test by hedonic scale with nine points.

Unselected and untrained tasters of both sexes, aged over 18 years were used, 60 tasters for each day of analysis (BRASIL, 2005). Tasters were recruited from the staff and undergraduate and graduate students of the São Paulo State University "Julio de Mesquita Filho", Faculty of Agricultural Sciences, Botucatu. Only individuals who agreed to participate and signed the Informed Consent were included.

Analysis of variance was carried out in a completely randomized design with 3 x 4 factorial design (pre-preparation x cooking), followed by Tukey's test for comparisons of means to 5% (GOMES, 1987).

3. RESULTS AND DISCUSSION

The sensory analysis of both sexes indicated that, in the case of whole unpeeled beets, the darker color was obtained when cooked in the oven (7.0 ± 1.6), followed by steam (6.3 ± 2.0) and immersion in water (5.8 ± 2.1), and the lighter color was obtained when the vegetable was cooked in pressure cooker (5.0 ± 1.9). There was no difference of aroma between thermal treatments, in the case of whole unpeeled beets (Table 2).

As for flavor attribute, immersion (6.1 ± 2.4), steam (5.7 ± 2.0) and pressure (5.6 ± 2.2) led to no significant differences, all of which received highest scores (which score) than the cooking in the oven (4.7 ± 1.8). The whole beet that had smoother skin was obtained when steamed, followed by cooking cycles in pressure cooker and immersion in water, and the softer was obtained through cooking in the oven. In the overall evaluation, the most accepted in the case of whole unpeeled beet was the cooking method in pressure cooker, followed by steam and immersion in water, and the less accepted was cooking in the oven.

In the case of whole peeled beets, the darker color was obtained through immersion in water, followed by oven and steam, and the beets cooked in pressure had greater loss of pigment and became the lightest. The best aroma of whole peeled beets was obtained in the oven, then followed by cooking in pressure and immersed in water, and the worst odor was obtained in steam. The texture was not significantly affected by thermal treatments. The most accepted whole peeled beets were the ones

cooked through immersion, followed by steamed and cooked in pressure cooker, and the less accepted were the ones baked in the oven.

For both sexes, darker colors of sliced beets were obtained in oven and steam, followed by immersion in water, and lightest color was obtained when cooking in pressure cooker. Sliced beets steamed and cooked in the oven had better aromas, followed by immersion in water. The worse odor was obtained in pressure cooker. The best flavor of sliced beets were obtained in the oven and when steamed and the worst flavors were obtained through immersion and pressure. Sliced beets in pressure cooker were softer than in other heat treatments. And according to the overall evaluation of both sexes, the cooking cycles in the steam and oven were more accepted, while immersion in water and pressure were less accepted. This may have occurred because the beets in immersion and pressure absorbed more water. Cooking cycles in oven and without contact with water seem to preserve the characteristic taste of beets.

Vitti et al. (2003) evaluated the overall appearance of different ways of cutting beets for ten days and showed that there was no difference between the types of cut in the first two days. This differs from what happened with the different types of cuts in the present work, where in the overall assessment, there was difference between the pre-preparations in the cooking cycles, namely, pressure, oven and immersion in water.

In general, for both sexes, the darker color was observed in sliced steamed beets and the lighter was observed in the sliced beets cooked in pressure cooker. The lowest score for aroma was obtained for sliced samples cooked in pressure cooker, and the best score was for sliced steamed beets. The most pleasant flavor was attributed for sliced samples cooked in the oven and the least enjoyable flavor was attributed for sliced beets cooked in pressure cooker. Softer beets were considered when whole, unpeeled and steamed and the most tender were the sliced cooked through immersion in water. In the overall assessment, the most accepted were sliced in the oven and steamed and the less accepted were the whole unpeeled beets cooked in the oven. This may be because the whole beets cooked in the oven were cooked for too long and there was a process of dehydration, making their aspect not so acceptable.

Regarding sensory analysis, for female tasters, in the case of whole unpeeled beets, color received higher score (dark

purple) when the vegetable was steamed and cooked in the oven, followed by the treatment immersion in water which did not differ statistically from the first, nor from the one lower score attributed to cooking under pressure (light purple). In whole unpeeled beets, there was no significant difference of color between all cooking methods. The darker, in the case of sliced beets, were observed for steamed cooked in the oven, followed by immersion, and the lighter were observed when cooked in pressure cooker. In absolute values, for women, darker purple was obtained when sliced and cooked in the oven and the lighter was obtained when sliced and cooked in pressure cooker (Table 3). Color is one of the most important attributes of food, because it determines its appearance and is used as a criterion to identify and judge the quality of the product (RIBEIRO, SERAVALLI, 2007). It was possible to note in this work that the evaluators used this criterion to judge the quality of the beet as there was wide variation in notes according to the different pre-preparation and cooking methods.

For the attribute aroma/odor, in the case of whole peeled and unpeeled beets, there was no significant difference between heat treatments. In the case of the sliced beets, better scores were given for steam and oven cooking, followed by immersion, and the worst score was given to cooking in pressure cooker. In absolute terms, women preferred the aroma of sliced beets cooked in the oven and the worst score was attributed to cooking sliced beets under pressure. As the sliced beets already have greater contact with water, cooking cycles in immersion and in pressure cooker left them more watery and with little flavor.

For flavor, whole unpeeled beets showed no significant difference between cooking cycles. In turn, in the case of whole peeled beets, higher scores were given to immersion in water and steamed, followed by cooked in pressure cooker and in the oven. Best flavors for the sliced beets were attributed for cooking in the oven and steamed, followed by immersion in water and cooked in pressure cooker, with no significant difference between them. In absolute values, the best flavor was given the sliced beets cooked in the oven and the worst was for sliced beets cooked in pressure cooker.

Regarding texture, in the opinion of women, whole unpeeled beets were softer when cooked in pressure cooker, followed by steamed, with no significant difference between them; and the most tender were obtained through immersion in water and the

Table 2. Sensory analysis of beet according to tasters of both sexes, with the cooking methods for the attributes color, aroma/odor, flavor, texture and overall evaluation for each pre preparation.

Tabela 2. Análise sensorial da beterraba, para provadores de ambos os sexos, com os métodos de cocção, para os atributos cor, aroma/odor, sabor, textura e avaliação global para cada pré preparo.

	Treatment	Color	Aroma/Odor	Flavor	Texture	Global avaluation
Shelled	Steam	6.3±2.0AB	5.6±2.1	5.7±2.0A	6.4±2.0A	5.5±2.2AB
	Pressure	5.0±1.9C	5.5±2.0	5.6±2.2A	5.9±2.2AB	6.0±2.0A
	Oven	7.0±1.6A	5.2±2.3	4.7±1.8B	5.1±2.4B	4.4±2.2B
	Immersion	5.8±2.1B	5.3±2.3	6.1±2.4A	5.6±2.2AB	5.3±2.1AB
	p	<0.0001	0.69	<0.0001	0.02	<0.0001
Unpeeled	Steam	5.9±1.9AB	5.1±2.0B	5.7±2.4A	5.5±2.0	6.2±2.1AB
	Pressure	5.3±1.7B	5.8±1.6AB	5.7±1.8A	5.9±1.5	6.1±1.7AB
	Oven	6.1±1.9AB	6.0±1.8A	4.6±2.4B	5.9±1.8	5.3±2.1B
	Immersion	6.2±2.0A	5.8±1.8AB	6.3±2.0A	5.6±1.8	6.4±1.8A
	p	0.04	0.04	<0.0001	0.40	0.01
Toast	Steam	7.3±1.5A	6.9±1.6A	6.5±1.9A	4.8±2.1B	6.7±1.8A
	Pressure	3.2±1.5C	3.9±2.1C	4.0±1.9B	6.3±2.1A	5.0±1.8B
	Oven	7.8±1.3A	6.3±1.8A	6.6±2.3A	4.7±2.0B	6.7±1.9A
	Immersion	5.2±1.5B	5.2±2.0B	4.8±1.0B	4.5±2.0B	5.1±1.7B
	p	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Capital letters in the column differ statistically from each other by 5% according to Tukey test (p <0.05).

Table 3. Sensory analysis of beet according to female tasters, with the cooking methods for the attributes color, aroma/odor, flavor, texture and overall evaluation for each pre-preparation.

Tabela 3. Análise sensorial da beterraba, para provadores do sexo feminino, com os métodos de cocção, para os atributos cor, aroma/odor, sabor, textura e avaliação global para cada pré preparo.

	Treatment	Color	Aroma/Odor	Flavor	Texture	Global avaluation
Shelled	Steam	6.4±2.0A	5.4±2.0	6.3±2.4	5.1±2.3AB	6.6±1.8A
	Pressure	4.9±2.1B	5.7±2.1	5.7±2.5	6.1±2.1A	6.1±2.1AB
	Oven	7.0±1.7A	5.0±2.3	5.0±2.5	4.3±2.0B	5.0±2.1B
	Immersion	5.7±2.4AB	4.9±2.5	5.3±2.5	5.2±2.5B	5.7±2.0AB
	p	0.001	0.55	0.18	0.03	0.02
Unpeeled	Steam	5.9±1.7	5.1±1.9	5.9±2.3A	5.4±2.0	6.3±2.1AB
	Pressure	5.5±1.9	6.1±1.6	5.3±1.8AB	6.1±2.1	5.6±2.0AB
	Oven	6.1±2.1	5.8±1.8	4.3±2.5B	6.2±1.7	5.0±2.4B
	Immersion	5.8±2.3	5.9±1.9	6.1±2.3A	5.7±1.8	6.4±2.1A
	p	0.75	0.15	0.01	0.30	0.04
Toast	Steam	7.3±1.4A	7.2±1.3A	6.5±1.9A	4.2±1.8B	6.7±1.6A
	Pressure	3.2±1.4C	3.6±1.7C	3.9±1.9B	6.4±2.0A	4.8±1.9B
	Oven	8.1±1.1A	6.7±1.6A	6.6±2.5A	4.8±2.1B	7.0±2.0A
	Immersion	5.1±1.8B	5.5±1.9B	4.7±2.1B	4.4±2.0B	5.4±1.9B
	p	<0.001	<0.001	<0.001	<0.01	<0.001

Capital letters in the column differ statistically from each other by 5% according to Tukey test (p <0.05).

cooked in the oven. Whole peeled beets showed no significant difference between cooking methods. The softer beet among the sliced was the cooked in pressure cooker, and the others more tender had no difference between them. In absolute numbers, in the opinion of women, the softer beets were the sliced cooked in pressure cooker and the most tender was the sliced and steamed.

In the overall evaluation, the best score for whole unpeeled beets was given for steam cooking, followed by pressure and immersion; the worst score was given for cooking in the oven. The immersion of whole unpeeled beets had the best score in the overall evaluation, followed by steamed and cooked in pressure. The lowest score was given for cooking in the oven.

Better scores in the case of sliced beets, in the overall evaluation, were attributed for cooking in the oven and steamed and the worst was attributed for immersion and pressure. The best overall evaluation, in general, in the opinion of women, was given to sliced and steamed beets, and the worse was given for sliced and cooked in pressure cooker. Possibly there was a preference for steam cooking because it is a method in which there is no direct contact of beets with water, reducing leaching of flavoring substances of beet, increasing acceptance. In turn, the pressure cooking method, besides the loss of compounds

to water, beets tend to become softer than in other forms of cooking studied.

In the opinion of men, in terms of color, in the case of whole unpeeled beets, highest score was attributed for cooking in the oven (dark purple), followed by steam cooking and immersion and in the case of lighter purple, was attributed for cooking in pressure cooker. Whole unpeeled were in order of dark purple to light purple: immersion, oven, steam and pressure. In the sliced, the darkest were those prepared in the oven and steamed, and the lighter were those prepared through immersion in water and pressure cooker. The darker beet, in all treatments was the one sliced and steamed and the lighter was sliced in pressure cooker (Table 4).

As for aroma, whole beets, peeled and unpeeled, showed no significant differences between cooking methods. In the case of the sliced beets, for men, steamed beets had the best aroma, followed by those cooked in the oven and the worst scores were awarded to cooking through immersion and pressure. Overall, the best aroma for men was attributed for sliced steamed beets and the worst odor was attributed for the sliced cooked in pressure.

In terms of flavor, whole unpeeled beets showed no significant differences between cooking methods evaluated. The

Table 4. Sensory analysis of beet according to male tasters, with the cooking methods for the attributes color, aroma/odor, flavor, texture and overall evaluation for each pre-preparation.

Tabela 4. Avaliação sensorial de beterrabas, para o sexo masculino, com os métodos de cocção, para os atributos cor, aroma/odor, sabor, textura e avaliação global para cada pré preparo.

	Treatment	Color	Aroma/Odor	Flavor	Texture	Global avaluation
Shelled	Steam	6.1±2.0AB	5.8±2.2	6.5±1.5	5.8±2.0AB	6.3±1.4
	Pressure	5.0±1.8B	5.3±1.8	6.0±1.8	5.9±1.9A	6.6±1.8
	Oven	7.0±1.4A	5.3±2.3	5.3±2.4	4.5±2.4B	5.4±2.1
	Immersion	5.9±1.8AB	5.7±2.0	5.8±1.8	5.4±1.7AB	5.8±1.9
	p	<0.001	0.70	0.12	0.03	0.06
Unpeeled	Steam	6.1±1.6A	5.1±2.1	5.4±2.5AB	5.5±1.9	6.0±2.1
	Pressure	5.1±1.6B	5.5±1.6	6.0±1.8AB	5.7±1.5	6.5±1.3
	Oven	6.1±1.8AB	6.1±1.8	4.9±2.3B	5.5±1.9	5.6±1.7
	Immersion	6.6±1.7A	5.7±1.8	6.5±1.6A	5.6±1.8	6.5±1.5
	p	0.009	0.20	0.02	0.95	0.11
Toast	Steam	7.2±1.6A	6.5±1.9A	6.5±1.9A	5.4±2.1AB	6.6±1.9A
	Pressure	3.2±1.7C	4.3±2.4C	4.2±2.0B	6.1±1.5A	5.1±1.7B
	Oven	7.5±1.4A	6.0±1.9AB	6.5±2.0A	4.7±2.0AB	6.4±1.8A
	Immersion	5.3±1.2C	4.8±2.0BC	4.9±2.0B	4.6±2.1B	4.8±1.5B
	p	<0.001	<0.001	<0.001	0.002	<0.001

Capital letters in the column differ statistically from each other by 5% according to Tukey test (p <0.05).

best flavor for whole beets, according to the opinion of men, was of those cooked through immersion, followed by pressure, steamed and cooked in the oven. Higher scores of flavor in the case of sliced samples were attributed for steamed and for those cooked in the oven and the worst score was attributed for those cooked in pressure cooker and through immersion. In absolute terms, the best flavors of whole unpeeled beets in the opinion of men were attributed for the ones steamed, and for the peeled beets, were attributed for those cooked through immersion in water and the ones sliced and steamed and cooked in the oven. And the worst taste was attributed for the sliced and cooked in pressure cooker.

In the attribute texture, in the opinion of men, whole beets with softer skin were obtained when cooked in pressure cooker, when steamed and when immersed in water and the most tender was the beet cooked in the oven. Whole unpeeled samples showed no significant difference. Among the sliced, the softer was obtained through cooking in pressure cooker, followed by steamed and the ones cooked in the oven and the most tender were obtained when cooked through immersion. In absolute values, the softer, in the opinion of men, were the sliced beets cooked in pressure cooker and the most tender were those unpeeled and cooked in the oven.

In the overall assessment, whole peeled and unpeeled beets showed no significant difference. The best scores in the overall evaluation, in the case of the sliced beets, were given to steam cooking and cooking in the oven and the worst scores were given for cooking in pressure cooker and immersion in water. In absolute terms, the highest score given by men, in the overall evaluation was for whole unpeeled beets cooked in pressure cooker and sliced steamed beets and the worse for sliced and cooked through immersion.

In a study with yam, samples cooked in water were softer than the steamed ones (ABOUBAKAR et al., 2009) as in the present work where the results of the sensory analysis show that in most pre-preparations, beets cooked in water were softer than steamed.

In a study of acceptability of peeled carrots, cooking in immersion, steam and microwave ranged from “liked” and “liked it very much” (RENNIE, WISE, 2010), different from the present work where acceptance ranged from “indiferente” to “liked it just a little”.

In relation to gender difference, it is observed that in this study, there were different preferences. Caetano et al (2015) evaluated stewed fig and found that its acceptability by men and women were similar. According to Kremer et al. (2005), genders have certain differences. It is also known that preferences and aversions for food change with growth, maturation and hormones, as the preference for sweetness and sugar consumption decreases among adolescents and adults. Both, preferences for flavors and foods, are, further, shaped by past experiences and associative learning. The neutral flavor, which is not preferred and neither rejected or the unpleasant taste can become preferred when it is associated with some kind of reward, often used by parents to make children eat (DREWNOWSKI, 1997).

4. CONCLUSIONS

The most accepted beets were the steamed, and this was probably because they do not have direct contact with

water as it happens when cooking in pressure cooker and immersion in water, losing the substances that give flavor to the water. Furthermore, steamed beets do not dehydrate as it happens in the oven, where the appearance is not well accepted.

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