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Evaluation of the effect of ripening on the sensory quality and properties of tamarillo (*Cyphomandra betaceae*) fruits

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Abstract

Tamarillo *(Cyphomandra betaceae)* fruits were sourced from a single farmer from the Central province of Kenya soon after harvesting. The fruits were then cleaned and sorted in order to remove all immature and damaged fruits. The resulting fruits were by visual inspection divided into eleven groups or ripeness scales depending on the degree of ripening and then subjected to a sensory evaluation for taste and colour using an untrained panel of 10 people. Objective measurements of firmness, colour, juice yield, pH and total soluble solids were also done for all the eleven ripeness groups.

The sensory score for both taste and colour increased with the degree of ripeness to reach a maximum at the ripeness scale of between 7 and 9, respectively, and thereafter decreased with further ripening. There was a remarkable change in the fruit pulp colour with L^* and b^* decreasing with increase in ripeness from 64.6 to 36.1 and 40.8 to 13.2, respectively, while a^* values increased from −4.3 to 8.5. Changes in fruit surface colour were well pronounced and decreased from 46.3 to 22.1 and 28.3 to 4.9 for L^* and b^*, respectively, while a^* increased from −4.9 to 28.3. There was progressive increase in juice yield (10.6–26.0%), total soluble solids (9.4–10.9) and pH (3.35–3.85) with increase in degree of ripeness. However, the firmness decreased from 115.5 to 71.6 N with increase in degree of ripeness. There was a linear relationship between the colour lightness coordinates for peel and pulp with an R^2 value of 0.989 indicating that fruit surface L^* values are good indicators of internal quality.

Keywords: Tamarillo fruits; Ripening; Sensory quality; Objective measurement; Fruit properties

1. Introduction

The tamarillo *(Cyphomandra betaceae)* fruits, also known as tree tomatoes are smooth skinned, oval shaped berries capped with a calyx and stem (Verheij & Coronel, 1992) and are usually 5–10 cm long and 4–5 cm wide (Fig. 1). Popeone et al. (1989) identified three main fresh market types based on the peel and pulp colour, which is either red, dark red or yellow depending on the variety. The fruit is native to Peru in South America but is grown in small quantities in many other parts of the world (Popeone et al., 1989). This interesting and unusual botanical relative of potatoes and tomatoes has commercial promise for many regions (Verheij & Coronel, 1992) and is an attractive option for processing into juice and wine as is already done in South America (Popeone et al., 1989).

As a practice, fruits should be harvested at the correct physiological maturity and state of ripeness (Harman & Patterson, 1984). Fruits that will be used for juice extraction should be processed at the degree of ripeness that

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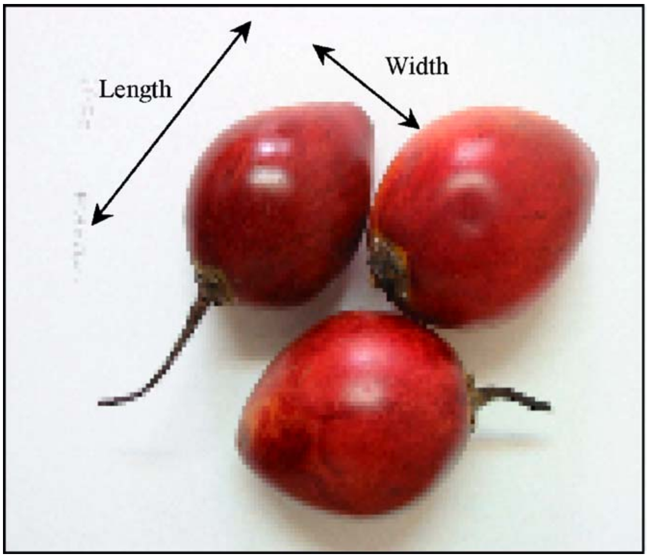

Fig. 1. Red tamarillo fruits in their fully ripe state.

allows the extraction of high quantities of high quality juice. The level of ripeness has a major influence on most of the quality aspects of a fruit as it influences firmness, quantities of sugars and vitamins, juice yield and the external and internal fruit colour (Fellows, 2000; Mahayothee, Leitenberger, Neidhart, Mũhlbauer, & Carle, 2002; Mohsenin, 1981; Sapii, Yunus, Muda, & Lin, 2000; Thiong'o, Njoroge, Kenji, & Mathooko, 2001; Zagory & Kader, 1989). Also, an increase in ripeness is usually accompanied by a reduction in firmness and acidity while juice yield and total soluble solids usually decrease. The sugar content of the fruit will initially increase with ripeness and then remain fairly constant as the fruit approaches senescence.

In the case of tamarillo, a definite trend in the changes of fruit quality indices with ripeness is yet to be determined although there has been some limited subjective studies. Heatherbell, Reid, and Wrolstad (1982) and El-Zeftawi et al. (1988) reported that the dark-purple skinned stage of tamarillo fruit represents the point of physiological maturity of the fruit as opposed to the green coloured stage. However they did not correlate these identified colour indices with the internal quality of the fruit, nor did they relate the visually observed colour changes to objective methods of colour measurement.

Cantwell (2003) has cited firmness, weight, absence of decay or discoloration, a sugar content of 8–10% and a high titratable acidity of 0.25–0.36% (citric acid) as the quality indicators of ripe tamarillo fruits. However, the authors did not give values of the colour indices or firmness which are usually the immediate field indicators of fruit maturity or ripening. There is therefore need to conduct objective measurements of these indicators and also correlate the surface properties of the fruit with the internal fruit quality.

The overall objective of the study was to determine the degree of ripeness of tamarillo fruits that will give the highest fruit sensory scores in terms of taste and appearance and to determine objective indices of the properties of both the fruit and extracted juices at various levels of ripeness.

2. Materials and methods

2.1. Preliminary experiments

Before the main experiments started preliminary experiments were done in order to determine the rate of ripening of the fruits. Mature green tamarillo fruits that had a^* colour values of -4.9 ± 0.1 on the Hunterlab colour-scale and which had just started showing signs of colour change (Sapii et al., 2000) were placed in a humidity chamber maintained at a temperature of 21 °C and a relative humidity of 60%. The storage conditions were chosen to reflect a typical non-refrigerated room storage environment in the central regions Kenya. The fruits were then allowed to ripen over a period of days. It was observed that it took approximately eleven days for the fruits to reach the senescence stage under these storage conditions.

2.2. Fruit acquisition

For the main experiments tamarillo (*Cyphomandra betaceae*) fruits were sourced from a single farmer in Kiambu district of Central Province in Kenya during the period of May–August, 2003. After harvesting the fruits were immediately transported to the Jomo Kenyatta University of Agriculture and Technology. On arrival the fruits were sorted to remove the rotten and discoloured ones, cleaned with chlorinated water and then placed in a humidity chamber (Model No. LHU-212M-E, Tapai Espec Corporation, Japan). The temperature and relative humidity of the chamber was set at 21 °C and 60% and the fruits were in units of 1 kg packets weighed using a top pan electronic balance (Model PB3002, Mettler Toledo Inc., USA). The fruits were used for experimental work within 24 h after being placed in the humidity chamber.

2.3. Sample preparation

After not more than 24 h of storage the fruits were removed from the humidity chamber and sorted out by visual inspection into eleven ripeness groups. These eleven groups depict the eleven day ripening stages at a storage temperature of 21 °C and a relative humidity of 60%. These groups were assigned ripeness scales ranging from RS1–RS11, with RS1 denoting very raw fruit while RS11 denoted very ripe fruit. The fruits were then used for sensory evaluation of quality.

Five fruits from each of the ripeness scales were randomly picked and placed in a bowl which was in turn placed on a long white table. The bowls were placed in such a way that during sensory evaluation the panelist had a clear view of all the eleven bowls. Each bowl was also randomly labeled with a letter ranging from A to K, which in