



(RESEARCH ARTICLE)



Physicochemical and sensory properties of tree tomato (*Cyphomandra betacea* (Cav.) Sendtner) drink

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Abstract

The aim of the present study was to investigate on the physicochemical properties of the tree tomato drink, its sensory properties and shelf-life. Three tree tomato drink treatments were obtained with three levels of dilution (w/v) of tree tomato paste: 1:1; 1:2 and 1:3 respectively for treatments T₁, T₂ and T₃. Physicochemical properties of drink treatments determined at the day of production (day 0) included pH, titratable acidity, dry matter content, sugar content and ash content. The pH, titratable acidity and sugar content were also evaluated during 12 weeks (84 days) of storage at room temperature under unlight at 1 week's intervals from day 0. The sensory attributes evaluated were colour, odour, taste, texture and overall acceptability. From the study, treatment T₁ had significantly ($P \leq 0.05$) the highest titratable acidity, dry matter content, sugar content and ash content while the pH of tree tomato drink increased with dilution. The pH, titratable acidity and sugar content of all the treatments remained unchanged ($P > 0.05$) during the storage period. The colour of treatment T₃ and the taste of treatment T₁ were lowly ($P \leq 0.05$) appreciated across all the treatments. However, treatment T₂ was highly ($P \leq 0.05$) preferred in terms of odour, consistency and overall acceptability. After storage, colour, odour and taste of all the treatments were similar ($P > 0.05$) while the consistency and overall acceptability of Treatment T₂ were more preferable ($P \leq 0.05$) than those of treatment T₁. Treatment T₂ could be recommended for manufacturing and the drink might be stored for 12 weeks and above.

Keywords: Tree tomato; Drink; Physicochemical and sensory properties; Storage

1. Introduction

Tree tomato or tamarillo (*Cyphomandra betacea* (Cav.) Sendtner), neglected andean crop [1], belongs to the solanaceae family such as tomato, eggplant, tamatillo, ground cherry and chilli pepper. It is a shrub native from South America in subtropical Andes. The plant could be native from Peru and Brazil [2] or Bolivia according to its area of origin [3, 4]. In fact, *S. betaceum* (*Cyphomandra betacea*) is closely related to *S. unilobum*, *S. roseum*, and in particular to *S. maternum*, all of which are found in Bolivia in wild status [4-7]. It is mostly cultivated in Brazil, Argentina, Mexico, Panama, Spain, India, South Africa and Unites States of America and the fruits have become an important marketable crop in these countries as well as in Colombia and New Zealand. The crop have been developed in Colombia, Ecuador and New Zealand where the production and exportation have increased in the last decades [5, 8-10]. The fruits naturally acidic are highly appreciated for their organoleptic and nutritional properties. They can be consumed in juice and as fresh fruit; cooked as ingredient for different dishes (stew and sauces) and dessert; prepared as chutney and pickles; eaten directly as salad or part of salads.

In Cameroon, tree tomato is an indigenous fruit which grows especially in the North-West region [11]. Many years ago, the fruit was consumed fresh and as juice. Culinary, it was also used as tomato substitute in sauce (stew) and soup preparation, salt or cube during preparation of yellow soup for Achu (traditional dish in Cameroon) consumption. At present, the tree is desperate and many farmers abandoned its cultivation rendering it uncommon and less marketable.

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While it is a promising crop for some regions characterised by a Mediterranean climate [12] such as the West and North-West region of Cameroon. On the other hand, tree tomato presents many nutritionally and health advantages which are benefit for human body.

Tree tomato fruit represents a source of provitamin A, vitamins C, E and B₂ and iron [13-16]. It possesses levels of nitrogen and free amino acids higher than those of most fruits except avocados and bananas and, its potassium and phosphorus contents are also high among fruits, which are normally poor sources of these elements [17]. It is also rich in fibres which contribute to lower the blood cholesterol level and facilitate digestion. Mature tree tomato fruit juice is traditionally used for the treatment of tonsillitis, high cholesterol and stomach pain [18]. It also contains a significant amount of bioactive compounds such as anthonyacins, phenolic compounds and carotenoids [19] which are endowed with antioxidant properties. The fruit is potentially a functional food ingredient and its use in human diets might provide protection and help to reduce oxidative damages in different vital organs [20] and, the presence of carotenoids and anthocyanins indicates biological, therapeutic and preventive properties [21]. It also presumed therapeutic value to the liver [17]. Due to its acidity, consumption of tree tomato fruits could help the body to lower the body weight, the blood cholesterol and sugar level; prevents high blood pressure level and contributes to maintain the heart in good health.

In order to valorise the indigenous fruits for their maintaining and cultivation, and also to increase the shelf-life of the fruits, the aim of the present study was to investigate on the physicochemical properties of the tree tomato drink, its sensory appreciation and shelf-life through evaluation of pH, sugar content and titratable acidity change during storage.

2. Material and methods

2.1. Preparation of tree tomato puree

Raw tree tomato fruits (mixture of yellow, red-purple and hybrid from the red-purple and yellow varieties) purchased from the local market in Bamenda, North-West region of Cameroon, were brought to the Food Technology and Post-Harvest laboratory of IRAD Bambui. After sorting, they were washed with potable water and boiled for few minutes. After cooling, the peelings were removed and the pulp mixed to become homogenous. The physicochemical composition of the pulp or puree is given below in table 1.

Table 1 Physicochemical composition of tree tomato puree

	Titratable acidity (% Citric acid)	pH	Dry matter (%)	Ash (%)	Sugar (°Brix)
Tree tamato puree	0.67±0.50	4.08±0.14	9.64±0.84	0.95±0.17	8.7±1.03

2.2. Preparation of tree tomato drink

Tree tomato drink was obtained by addition of potable water to the puree obtained and the mixture sieved doubly using a muslin cloth. The drink was then successively pasteurised (75 °C/3-5 s) in presence of 10% (w/v) of sugar added at 60-65 °C, packaged in sterilised glass bottles, sterilised by boiling (20 min), cooled at room temperature and stored in the same conditions and out of sun light.

According to the quantity of water added to the puree, three treatments were obtained:

- Treatment T₁: 1 kg of puree and 1 l of water (dilution 1:1 (w/v))
- Treatment T₂: 1 kg of puree and 2 l of water (dilution 1:2 (w/v))
- Treatment T₃: 1 kg of puree and 3 l of water (dilution 1:3 (w/v))

The samples obtained were submitted to physicochemical analysis and sensory evaluation.

2.3. Physicochemical analysis

The physicochemical properties analysed were:

- Titratable acidity by titration with Sodium Hydroxide (NaOH) 0.1 M with phenolphthalein 0.5% as indicator [22]. The titratable acidity (TA) was expressed as citric acid content (% citric acid) using a formula:

$$\text{TA (\% citric acid)} = (\text{V NaOH (ml)} \times 0.1 \times 0.065 \times 100) / \text{Volume of sample (ml)}$$

- pH using a manual pH-meter
- Sugar content (°Brix) with an eclipse handled refractometer
- Dry matter as described by AOAC [22].
- Ash content according to AOAC [22].

pH, titratable acidity and sugar content were also determined during 84 days (12 weeks) of storage at regular intervals of 02 weeks from the day of production (manufacturing) or day 0.

2.4. Sensory evaluation

Sensory evaluation of all tree tomato drink treatments was carried out using a five-point hedonic scale with the following as categories: Excellent=5; Very Good=4; Good=3; Fair=2 and Poor=1. Colour (appearance), flavour (aroma), texture, taste and overall acceptability of tree tomato drink treatments were evaluated by an untrained panel of 30 persons between 20 and 60 years old who were made of researchers, technicians and students on internship of the centre of IRAD-Bambui. It was done on the day of manufacturing (day 0) and at the end of the storage period (84 days or 12 weeks).

2.5. Statistical analysis

Data obtained were expressed as Mean±SD and subjected to the Analysis of variance (ANOVA) using the Statgraphics Plus, version 5.0 statistical package. The means obtained were separated using the Fischer Test (LSD) at 95% confidence level.

3. Results and discussion

3.1. Physicochemical properties of tree tomato drink

The physicochemical properties of tree tomato drink treatments are presented in table 2. The pH values obtained were not significantly different ($P>0.05$) between treatments T₁ and T₂ and, treatments T₂ and T₃. However, Treatment T₃ showed the highest pH value which was significantly different ($P\leq 0.05$) to that of treatment T₁. Thus, the increase of the dilution led to the increase of pH due to the fact that, the pH value of the drinking (potable) water is almost neutral (slightly acidic) and at low level, it might not significantly affect the pH of the solution. Treatment T₁ showed the highest value ($P\leq 0.05$) of titratable acidity; dry matter, sugar and ash contents. Moreover, the increase of the level of dilution involved the decrease of those parameters. This result was expected by the dilution of components and also considering the fact that potable water doesn't have or has very low (traces) of titratable acidity or citric acid content; dry matter, sugar and ash contents.

Table 2 Physicochemical properties of tree tomato drink treatments

Parameters	Treatments		
	T ₁	T ₂	T ₃
pH	4.28±0.10b	4.44±0.15ab	4.56±0.16a
Titratable acidity (% citric acid)	0.60±0.02a	0.41±0.02b	0.30±0.02c
Dry matter (%)	14.54±2.28a	12.06±0.83b	11.38±1.11c
Sugar content (°Brix)	14.2±2.01a	11.6±1.02b	10.6±1.51b
Ash content (%)	0.42±0.05a	0.28±0.03b	0.16±0.03c

(a, b, c): The values with the same letter in the same row are not significant different ($P>0.05$) T₁: 1 kg of tree tomato puree and 1 l of water (dilution 1:1 (w/v)); T₂: 1 kg of tree tomato puree and 2 l of water (dilution 1:2 (w/v)); T₃: 1 kg of tree tomato puree and 3 l of water (dilution 1:3 (w/v)).

3.2. pH, titratable acidity and sugar content change in tree tomato drink during 84 days of storage

The figure 1 below shows the pH change of tree tomato drink treatments during 84 days (12 weeks) of storage. pH values of each treatment were not significantly ($P>0.05$) affected with increasing of storage duration. This results is in accordance with that of El-Dengawy *et al.* [23] who did not observed significant change on pH during 18 Months storage of tomato juice. The tomato juice was sterilised at 100 °C during 30 min and pH values varied between 4.5 and 4.2. In fact, during heat treatment (boiling, pasteurisation or sterilisation), there should be enzyme denaturation and microorganisms' destruction and subsequently low metabolic activity leading to acidic or basic components production,

which could significantly induce pH change. Also, the pH values of drink treatments varied from 4.28 to 4.62 during storage and, higher acidity levels (pH <4.6) are often unfavourable to the survival of microorganisms [24]. Tilahun *et al.* [25] obtained rather an increase of pH values of tomato juice (1 ml juice/19 ml distilled water) with increasing storage duration and could be explained by the fact that the extracted juice was not pasteurised or treated. However, during storage, pH of tomato increase [26-28] as result of consumption of various organics acid [29]. According to Pinzón-Gómez *et al.* [30], fruits (tamarillo) which were not immersed in calcium chloride showed lower pH values during storage compared to the fruits that received applications of calcium, and may be correlated to the inhibition of the catalytic activity of enzymes in presence of calcium [31].

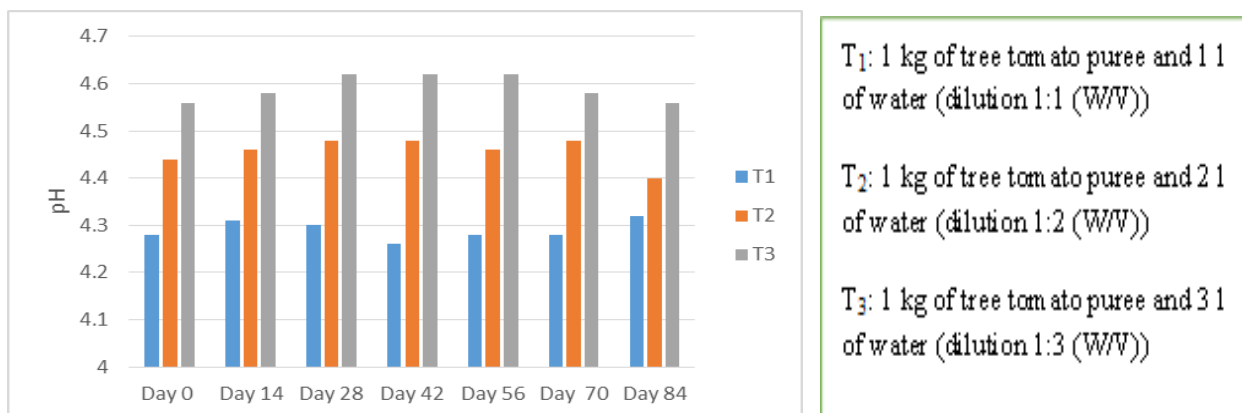


Figure 1 Histogram of pH change of tree tomato drink during 84 days (12 weeks) of storage

During the storage period, treatment T₃ had the highest pH value and this value significantly different ($P \leq 0.05$) with that of treatment T₁. This result should be in relation with the high pH value of treatment T₃ on the manufacturing day (beginning of storage) considering the low microbial activity and the low enzymes' activity due to low pH and heat treatment.

The titratable acidity (% citric acid) of all the tomato drink treatments remained almost constant ($P > 0.05$) during the storage with treatment T₁ having the highest ($P \leq 0.05$) value and treatment T₃ the lowest ($P \leq 0.05$) value (figure 2). During tree tomato drink production, there should be enzymes' denaturation and microorganisms' destruction due to heat treatment (boiling, pasteurisation and sterilisation). Also, the low pH values of tree tomato drinks are not favourable to microorganisms' activity. Thus, the result obtained is similar to that of El-Dengawy *et al.* [23] who worked on tomato juice and might be as result of low or neglected metabolic activity. However, the decreasing of titratable acidity (TA) of tomato gradually observed during storage by Abiso *et al.* [28] and Tilahun *et al.* [25] could be related to the metabolic activity. In fact, reduction in acidity during storage might be associated to the conversion of organic acids into sugars and their derivatives [32].

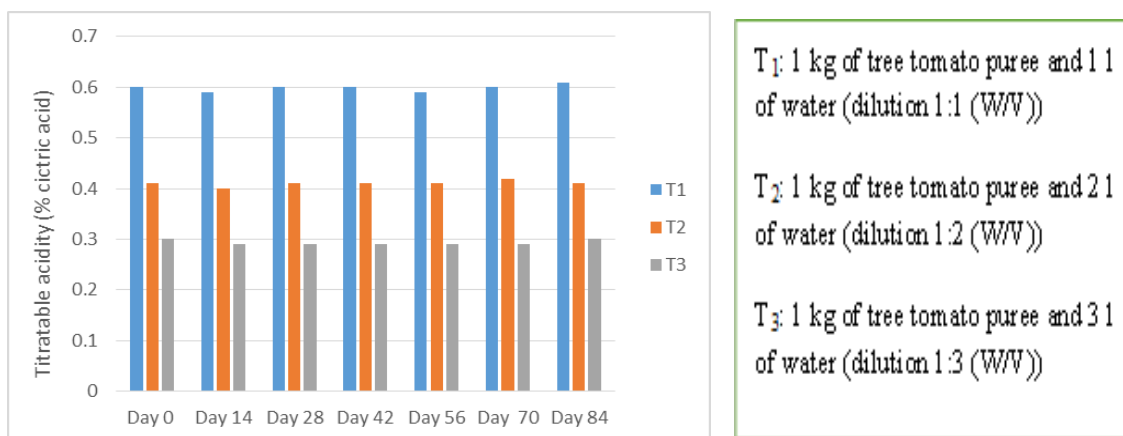


Figure 2 Histogram of titratable acidity (% citric acid) change of tree tomato drink during 84 days (12 weeks) of storage

The figure 3 reveals that the sugar content remained almost stable during 12 weeks of storage. Moreover, treatment T₁ persisted to present significantly (P<0.05) the highest sugar content while treatments T₂ and T₃ were similar (P>0.05). The result observed indicates almost no sugar metabolism during storage which might be as the consequence of enzymes' denaturation during boiling, pasteurisation or sterilisation (heat treatments) and also absence or low microbial activity resulting of the heat treatments and the low pH (acidic pH) of the drink which is not suitable for the growth of several microorganisms [24]. This is in agreement with previous studies which indicated that application of CaCl₂ (Calcium chloride) leads to greater stability in the total soluble solids or TSS (amount of sugar and soluble minerals present in fruits and vegetables) change, because calcium intervenes on the inhibition of pectic enzymes and stability of the metabolic rate of fruit [33]. Nevertheless, studies done by Márquez *et al.* [34] revealed that the total soluble solids of tamarillo (tree tomato) tends to increase at the beginning of storage and, it was justified by the hydrolysis of starches, which are broken down into simpler disaccharides and monosaccharides as sucrose, fructose and glucose [35].

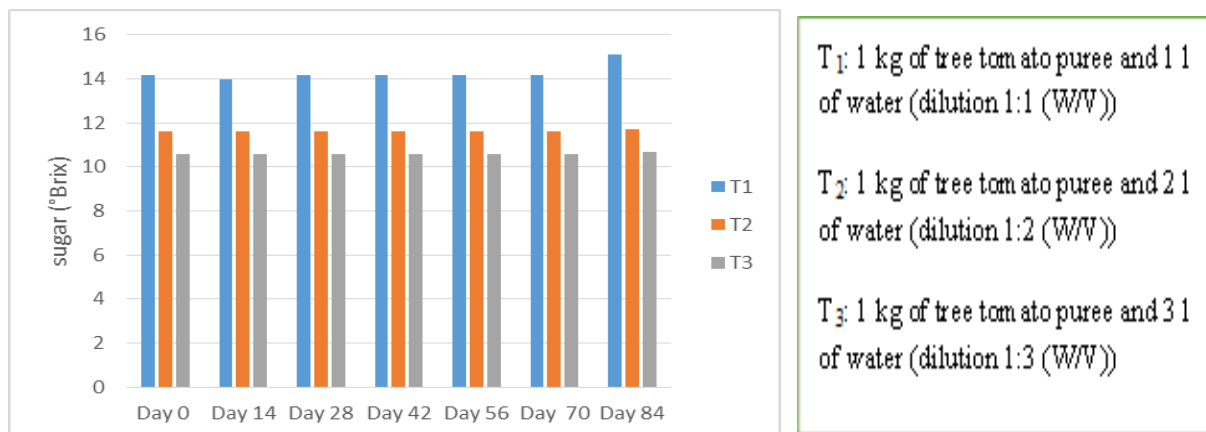


Figure 3 Histogram of sugar (°Brix) change of tree tomato drink during 84 days (12 weeks) of storage

3.3. Sensory evaluation

Sensory evaluation scores of different tree tomato drink treatments are presented in table 3 below. The colour of treatment T₃ was less appreciated showing that, at high level of dilution, there is loss of the natural colour (dominantly purple) of the tree tomato drink. Concerning the odour, treatment T₂ had the best score (P<0.05) while treatments T₁ and T₃ were comparable (P>0.05). This result may be due to the strongest (treatment T₁) and the lowest (treatment T₃) odour of the tree tomato when lowly and highly diluted respectively which were not too appreciated by panellists. The taste of treatment T₁ was significantly (P<0.05) less appreciated and it might be due to the high level of acidity of the drink at low level of dilution. The consistency of treatment T₂ obtained significantly (P<0.05) the highest score and treatment T₃ significantly (P<0.05) the lowest. It can be justified by the lightness of the drink at high level of dilution or the thickness at low level. The treatment T₂ indicated significantly (P<0.05) the highest score of overall acceptability while other treatments were comparable (P>0.05). Also, for all the sensory attributes evaluated, treatment T₂ presented the highest score. Thus, according to the panellists, the tree tomato drink was better accepted when there was slightly low colour, acidic taste and thick consistency with no strong odour of the tree tomato in the drink.

Table 3 Sensory evaluation scores of fresh tree tomato drink

Sensory attributes	Treatments		
	T ₁	T ₂	T ₃
Colour	3.85±0.89a	3.9±0.78a	2.90±0.93b
Odour	3.45±0.81b	3.72±0.90a	3.20±0.91b
Taste	3.32±0.85b	3.90±0.81a	3.25±0.98a
Consistency	3.40±0.77b	3.82±0.84a	3.02±0.76c
Overall acceptability	3.37±0.80b	3.85±0.80a	3.17±0.98b

(a, b, c): The values with the same letter in the same row are not significant different (P>0.05); T₁: 1 kg of tree tomato puree and 1 l of water (dilution 1:1 (w/v)); T₂: 1 kg of tree tomato puree and 2 l of water (dilution 1:2 (w/v)); T₃: 1 kg of tree tomato puree and 3 l of water (dilution 1:3 (w/v)).

After 12 weeks' storage, the colour, odour and taste of the tree tomato drink samples (treatments) were not significantly different ($P>0.05$) according to the panellists (table 4). However, the scores of the consistency and the overall acceptability were highest with treatment T₂ and the values observed significantly different ($P\leq 0.05$) with those of treatment T₁.

Table 4 Sensory evaluation scores of tree tomato drink at the end of storage

Sensory attributes	Treatments		
	T ₁	T ₂	T ₃
Colour	3.66±0.84a	3.56±0.81a	3.5±0.82a
Odour	3.46±0.73a	3.4±0.85a	3.16±1.01a
Taste	3.13±0.73a	3.56±0.62a	3.33±1.12a
Consistency	3.03±0.92b	3.56±0.77a	3.33±0.84ab
Overall acceptability	2.90±0.75b	3.48±0.63a	3.30±0.98ab

(a, b, c): The values with the same letter in the same rows are not significant different ($P>0.05$) T₁: 1 kg of tree tomato puree and 1 l of water (dilution 1:1 (w/v)); T₂: 1 kg of tree tomato puree and 1 l of water (dilution 1:2 (w/v)); T₃: 1 kg of tree tomato puree and 1 l of water (dilution 1:3 (w/v)).

4. Conclusion

The tree tomato drink treatment present the highest titratable acidity, dry matter content, sugar content and ash content when low diluted (treatment T₁) and also, its pH increases with dilution. Titratable acidity, sugar content and pH of the tree tomato drink is not affected after 12 weeks' storage. At 1:2 (w/v) dilution (treatment T₂), the tree tomato is more preferable concerning the odour, consistency and overall acceptability while at 1:1 (w/v) dilution (treatment T₁), the taste is less appreciated. The increase of the dilution leads to a decrease of appreciation of the colour. After 12 weeks' storage all the treatment presents the same level of appreciation in term of colour, odour and taste. However, the consistency and the overall acceptability of treatment T₂ are more accepted than that the ones of treatment T₁.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest

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