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RESEARCH ARTICLE

Formulation and sensory evaluation of Sweet lime peel vinegar, Sweet lime fruit-peel combo vinegar and sweet lime fruit vinegar

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Abstract

Fruit peels are the outer covering of the fruits which behave as a physical as well as a chemical barrier. Along with protecting the fruit from the environment, and micro, and macro organisms, the fruit peel, indeed, has several other health benefiting constituents such as dietary fiber, and phyto-nutrients that help accomplish overall wellness. The study was carried out to develop vinegar from the sweet lime peel, which is usually discarded after squeezing the juice and to compare the sensory qualities of the sweet lime peel vinegar with vinegar prepared from sweet lime fruit-peel combo and sweet lime fruit. Vinegar undergoes two-stage fermentation, firstly by anaerobic fermentation of sugar to ethanol by yeast and secondly by conversion of ethanol to acetic acid aerobically. *Saccharomyces cerevisiae* was used to carry out anaerobic fermentation, while Acetobacter xylinum culture was added to facilitate aerobic fermentation. The time period for vinegar production was 25 days. The pH of the three vinegar preparations measured using pH meter showed that the initial pH of 3.80 decreased to 3.22.The overall acceptability of sweet lime fruit-peel combo vinegar and sweet lime fruit vinegar were rated as excellent whereas sweet lime peel vinegar was rated as very good on a 5 point hedonic scale by a 20 member taste panel.

Introduction

Fruit peels are the major byproduct of any food and beverage industry, and it becomes a financial burden on the industry to decompose it, without causing any severe environmental pollution. If these fruit peels, being a byproduct, can be converted to some useful components to be used in food and healthcare industries, then the industry can gain profit, and at the same time the product can be affordable to common people (Prakash et al., 2013).Possible products that can be considered from fruit waste are as candied peel, oils, pectin, reformed fruit pieces, enzymes, wine and vinegar (Singh, 2007).

Vinegar, from the French *vin aigre*, meaning "sour wine," can be made from almost any fermentable carbohydrate source, including wine, molasses, dates, sorghum, apples, pears, grapes, berries, melons, coconut, honey, beer, maple syrup, potatoes, beets, malt, grains, and whey. Initially, yeasts ferment the natural food sugars to alcohol. Next, acetic acid bacteria (*Acetobacter*) convert the alcohol to acetic acid (Johnston and Gaas, 2006).

Sweet lime is known as Mousambi in India. Its skin is greenish orange in color and its flesh is pale yellow in color. Sweet lime is mainly used for preparing fresh juice. The skin possesses essential oils which is extracted and used in aromatherapy and perfumes. Sweet lime has been traditionally used for several medicinal purposes. In Mexico the fruit is used for its Antihyperglycemic and Antihypertensive activity (Perez et.al 2010). The fruit has shown anti-inflammatory and antithrombotic action (Nogata et.al 1996, Nogata et.al 2006). In the Mediterranean

regions the peel is chewed to sweeten the breath. It is used to treat partial paralysis and the juice extracted from the peel is effective against snake bite. The ash of the peel is good against leprosy and skin diseases (Lev et.al. 2008).

Sensory evaluation has been defined as a scientific method used to evoke, measure, analyze, and interpret those products as perceived through the senses of sight, smell, touch, taste and hearing (Stone, 1993).Sensory testing utilizes one or more of the five senses to evaluate foods. Taste panels, comprising groups of people, taste specific food samples under controlled conditions and evaluate them in different ways depending on the particular sensory test being conducted.

2. MATERIALS AND METHODS

2.1. Formulation of sweet lime peel vinegar, sweet lime fruit-peel combo vinegar and sweet lime fruit vinegar.

The sweet lime peel vinegar was formulated using sweet lime peel, sugar, water and starter culture. In a clean, sterilized glass jar; 200 g of sweet lime peel (steamed & cut into thin strips), 800 ml of distilled water, 100 g of sugar and 3 g of starter culture: yeast (*Saccharomyces cerevisiae)* was added and allowed to ferment anaerobically for 10 days for the production of ethanol by the action of *Saccharomyces cerevisiae.* After 10 days, the contents of the glass jar were strained to remove the peel and *Acetobacter xylinum* culture was added to the filtrate. The glass jar was then covered with a muslin cloth to facilitate aerobic fermentation for 11-15 days. *Acetobacter xylinum* aids the conversion of ethanol to acetic acid, thereby producing vinegar. The same procedure was followed for sweet lime fruit vinegar using 200 g of sweet lime fruit and sweet lime fruit – peel vinegar using 100 g of sweet lime fruit and 100 g of sweet lime peel (steamed & cut into thin strips). The characteristic sour taste and pH of the end product was used as a parameter to indicate the preparation of vinegar.

2.2. pH value

The pH was assessed every four days for all the three types of vinegar. The pH of the three vinegar preparations was determined using pH meter with a standard acidic range.

2.3. Determining the acceptability of the three types of vinegar preparation

Twenty post graduate students were chosen as panel members to score the sensory attributes such as appearance, color, texture, flavor and taste on a five point Hedonic scale with criteria Excellent, Very good, Good, Fair and Poor for sweet lime peel vinegar, sweet lime fruit – peel combo vinegar and sweet lime fruit vinegar.

A single portion of each vinegar preparation was served in a glass bowl. The judges were instructed to fill the five point hedonic score card for each vinegar.

2.4 Statistical Analysis

The data obtained for sensory evaluation were subjected to Arithmetic mean and Standard deviation.

3. RESULTS AND DISCUSSION

Fig 1. Sensory evaluation of three vinegar preparations

3.1.Formulation of three types of vinegar from sweet lime fruit

The inoculated bottles were stored in a clean cool place to prevent contamination. The changes in colour after aerobic fermentation that were observed are presented in Table.1.

3.2. pH value

The pH of the three vinegar preparations was determined on three days, day 1, day 6 and day 12 using pH meter with a standard acidic range. The pH of the three vinegar preparations on 1st, 6th and 12th day are presented in Table.2.

From Table 2 it is evident that there was a decrease in pH values from the initial pH in all the three vinegar preparations. The decrease in pH indicates the production of acid by oxidation of the ethanol (produced by yeast-*Saccharomyces cerevisiae* during aerobic fermentation) by the acetic acid bacteria during anaerobic fermentation (Raspor., 2008). The pH of the Sweet Lime peel vinegar and Sweet Lime fruit-peel combo vinegar plateaued 3.34 and 3.27 respectively, on the 12th day indicating that all the ethanol has been converted to acetic acid and no more was present to be oxidised it acetic acid by acetic acid bacteria.

3.3. Sensory evaluation

The sensory evaluation of the three vinegar preparation is presented in figure 1.The overall acceptability of the Sweet lime fruit-peel combo vinegar and Sweet lime fruit vinegar were rated as excellent on the five point hedonic scale, while Sweet lime peel vinegar was rated as very good on the five point hedonic scale. Though Sweet lime fruit vinegar scored higher score (4.11±0.7) in overall acceptability on a total score of 5 than Sweet lime fruit-peel combo vinegar (4.04±0.7), nutritionally the latter can be considered a better option than the former. Sweet lime fruit-peel combo vinegar has equal proportion of fruit and peel. The brownish yellow colour of the sweet lime peel vinegar and sweet lime fruit-peel combo vinegar is due to the presence of carotenoids in the peels. Analysis of carotenoid composition in the peel of a commercial lime cultivar revealed a profile very similar to the characteristic of chloroplastic tissues, being lutein and their isomers the most abundant carotenoids (about 51% of total), followed by β-carotene (24.2%), α-carotene (10.0%) and β-cryptoxanthin (4.3%) (Agocs et al., 2007).Dietary carotenoids are thought to provide health benefits in decreasing the risk of disease, particularly certain cancers and eye disease. The peel of the Sweet lime has a bitter crystalline glucoside called hesperidin. This may be the reason for the bitter after taste in the Sweet lime. The bitterness of the peel in Sweet lime fruit-peel combo vinegar was subdued by the sweetness of the fruit.

4. CONCLUSION

In conclusion it can be stated that the three formulated vinegar can be put to use nutritionally and therapeutically. The study's main objective was to develop a novel product from the peel which is usually wasted. The peel contains many vital nutrients and non-nutrient components. The peels are rich in anti-oxidants such as anthocyanins, lutein, carotenoids; dietary fiber, has considerable amount of minerals and vitamins. Therefore the formulated sweet lime peel vinegar, sweet lime fruit – peel combo vinegar and sweet lime fruit vinegar are much healthier than the commercially available vinegar.

Fig 2. Acceptability and Palatability of the Three Vinegar Preparation

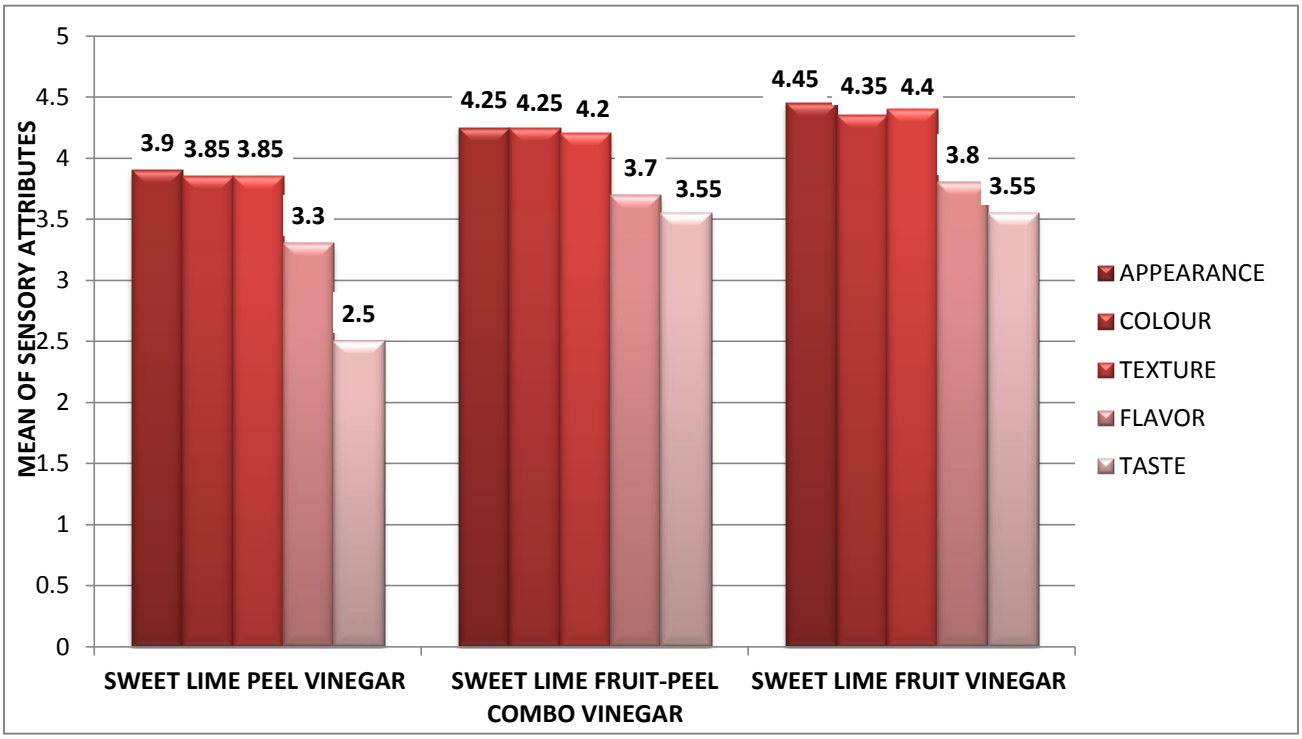

Table 1. Change in colour before and after fermentation

Vinegar	Colour before fermentation	Colour after fermentation
Sweet Lime peel vinegar	Pale Yellow	Brownish Yellow
Sweet Lime fruit-peel combo vinegar	Pale Yellow	Brownish Yellow
Sweet Lime fruit vinegar	Off White	Pale Brown

Table 2. pH of the vinegar formulations

Day	pH of sweet lime peel vinegar	pH of sweet lime fruit-peel combovinegar	pH of sweet lime fruit vinegar
1st Day	3.63	3.80	3.75
6th Day	3.34	3.26	3.42
12th Day	3.34	3.27	3.22

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