



Analysis of Nutrient Content and Physicochemical Properties of Newly Developed Sweet Lime Peel Vinegar and Sweet Lime Fruit-Peel Combo Vinegar

KEYWORDS

polyphenols, flavonoids, Viscosity, Density, refractive index, acid value

Priyadarshini . S

Dr. (Mrs.) Sheila John

Associate Professor and Head, Department of Home Science, Women's Christian College, Chennai – 600 006

ABSTRACT *The fruit peels are very rich in bioactive compounds which can be used as antioxidants and antimicrobial agents. The current researches on the fruit peels are following a trend to identify an efficient way to extract the bioactive compounds having antioxidant and antimicrobial properties from the fruit peels, to use it for better health development. The nutrient analysis of sweet lime peel vinegar and sweet lime fruit-peel combo vinegar revealed that iron, folate, total polyphenols and flavonoids concentration were higher in sweet lime peel vinegar than the sweet lime fruit-peel combo vinegar. Viscosity, Density, refractive index and acid value of the sweet lime peel vinegar was 521cps, 1.08, 1.33, 85.15 respectively and sweet lime fruit-peel was 545 cps, 1.04, 1.33, and 224.5 respectively. The formulated sweet lime fruit-peel vinegar was incorporated into twenty dishes to increase the nutrient content, to benefit general health and to treat specific conditions like diabetes mellitus, cardio vascular diseases and obesity.*

1. INTRODUCTION

Fruits are an important source of compounds called phytonutrients such as ascorbic acid, flavonoids, carotenoids, phenolic acid, tocopherol and sulphur containing compounds, which possess antioxidant properties. These phytochemicals scavenge the free radicals circulating in the body, thereby reducing the oxidative stress caused by the free radicals. The peel and seeds of fruits are also a rich source of antioxidant components. Recent studies indicate that the peel yields 1000 folds more phenolic compounds than pulp. Review suggest that flavonoids and phenolics were significantly greater in peel than the pulp and hence their fruit husk extracts shows antiproliferative activity against a panel of human oral, colon and prostate cancer cell lines (Seerama, 2005).

The sweet lime is valued in India because of its therapeutic cooling effect in cases of fever and jaundice. In India, the pickled fruit is eaten to relieve indigestion. Al-Ghafiqi and Ikn al-Baytai cited various physicians who describe the use of the sweet lime to strengthen the stomach, to increase appetite, to prevent thirst, to halt diarrhea and vomiting, to strengthen the heart and to reduce fever. Sweet lime was also recommended for treating Jaundice, skin diseases, snakebites, scorpion bite, internal infections and hemorrhoids (Lev et al., 2008). The sweet lime peel constitutes essential components such as essential oil, dietary fibre and pectin which confers various health benefits to humans. Citrus essential oil has been known not only for its aromatic functions but also for its physiological properties, such as chemoprevention against cancer and aromatherapy effects (Sawamura 2010). The essential oil extracted from lime peel by cold pressing method had hydrocarbons, aldehydes and alcohols as abundant compounds (Minh Tu et.al, 2002). In food industries, pectic substances are widely used in the manufacture of jams, jellies, marmalades, and fruit preserves of all kinds, especially the natural pectin content of fruits, like orange peel (Zykwinska et al., 2009). In a comparative study where pectin extraction from different varieties of citrus fruits ie, Feutral, Musambi, Kinnow and Malta, were analysed, the maximum pectin extraction was from Feutral followed by Musambi, Malta and kinnow.

Vinegar is used extensively in food processing as an important preservative and acidulant in pickles, salad dressings, tomato products, and mustards. Vinegar is also used in the curing of meat and in the canning of certain vegetables. Apart from its abundant use in cooking, cleaning, preserving vegetables and fruits, and as a disinfectant, vinegar has various health benefits. Vinegar specifically apple cider vinegar is rich in beneficial enzymes and is used medicinally for centuries. Apple cider vinegar helps strengthen the immune system, control weight, promote good digestion, balance blood pH levels and remove toxic sludge from the body (Quigley et al 2010). Liatiset al (2010) observed that vinegar decreases postprandial hyperglycemia in patients with Type II diabetes. Commercial rice vinegar showed antimicrobial activity against E.coli and Salmonella enterica, which were inoculated on shredded iceberg lettuce.

The present study was carried out to analyse the nutrient content and physicochemical properties of the newly formulated vinegar preparations and to incorporate the formulated vinegar into twenty dishes.

2. MATERIALS AND METHODS

2.1 Preparation of Vinegar

The two vinegar formulation were prepared by two-stage fermentation process, firstly by anaerobic fermentation of sugar to ethanol and secondly by conversion of ethanol to acetic acid aerobically. The sweet lime peel vinegar and sweet lime fruit-peel combo vinegar were prepared in clean and hygienic environment.

2.2 Nutrient analysis of the two vinegar preparations

The detection of the concentration of acetic acid and the nutrient content in sweet lime peel vinegar and sweet lime fruit-peel combo vinegar with regard to carbohydrate, protein, fat, tannins, total polyphenol content, flavonoids, iron, vitamin A, vitamin C, vitamin B₁, vitamin B₂, vitamin B₃, vitamin B₆, vitamin E, vitamin K, folate and dietary fiber was carried out in a laboratory. The values obtained for each of the vinegar was compared with each other. The methods used for determining the nutrient content in the vinegar samples are present in Table. 1.

2.2 Analysis of the physicochemical properties of the three vinegar preparations.

The physicochemical properties such as density, viscosity, acid value and refractive index of the three vinegar preparation were assessed by different methods and are presented in Table. 2.

Table 1. Methods used for determining the nutrients

NUTRIENT	METHOD
Acetic acid	Titrimetry
Carbohydrate	Gravimetry
Dietary Fibre	Gravimetry
Fat	Hydrolytic method
Flavonoids	HPLC
Folic acid	HPLC
Iron	Atomic Absorption spectroscopy
Phenols	HPLC
Protein	KjeldhalFlaskMethod
Tannins	HPLC
Vitamin A	UV Spectroscopy
Vitamin B ₁	HPLC
Vitamin B ₂	HPLC
Vitamin B ₃	HPLC
Vitamin B ₆	HPLC
Vitamin C	Titration
Vitamin E	HPLC
Vitamin K	HPLC

Table 2. Methods used for determining physical properties

Physicochemical properties	Value
Viscosity	Viscometer
Density	Densimeter
Refractive index	Refractometer
Acid value	Titration

2.3 Formulation of recipes using sweet lime fruit-peel combo vinegar

The formulated sweet lime fruit-peel combo vinegar was incorporated into a variety of dishes to increase the nutrient content, to benefit general health and to treat specific conditions like Diabetes Mellitus, Cardio Vascular Diseases and Obesity. Twenty recipes were formulated and standardized using sweet lime fruit-peel combo vinegar. Sensory evaluation for these recipes was done by a panel of 20 judges. The score obtained for the sensory qualities were assessed and compared such as appearance, color, texture, flavor, taste and overall acceptability.

3. RESULT AND DISCUSSION

3.1 Nutrient and physicochemical properties analysis of sweet lime peel vinegar and sweet lime fruit-peel combo vinegar

The nutrient composition of Sweet lime peel vinegar and Sweet lime fruit-peel combo vinegar are presented in the Table 3a.

Table 3a. Nutrient content analysis

Nutrient	Content per 100g	
	Sweet lime peel vinegar	Sweet lime fruit-peel combo vinegar
Acetic acid (in gram)	19.22 g	38.04 g
Carbohydrate (in gram)	12.07 g	13.64 g
Protein (in gram)	12.26 g	14.62 g
Fat (in gram)	0.16 g	0.5 g
Iron (in mg)	10.2 mg	5.45 mg
Folate (in µg)	5.33 mcg	3.44 mcg
Tannins (in mg)	14.5 mg	19.4 mg
Total Polyphenols (in mg)	20.4 mg	10.3 mg
Flavonoids (Total) (in mg)	14.14 mg	9.78 mg
Vitamin A (in mg)	1.34 mg	2.34 mg
Vitamin B ₁ (in mg)	43.7 mg	43.9 mg
Vitamin B ₂ (in mg)	62.2 mg	62.2 mg
Vitamin B ₃ (in mg)	65.4 mg	63.45 mg
Vitamin B ₆ (in mg)	12.2 mg	12.20 mg
Vitamin C (in mg)	56.7 mg	95.6 mg
Vitamin E (in mg)	In traces	3.4 mg
Vitamin K (in mg)	Below detectable level	Nil
Dietary Fibre (in g)	4.34 g	6.57 g

The carbohydrate and protein content of sweet lime fruit-peel combo vinegar were higher than sweet lime peel vinegar except fat which was found to be higher in the latter. In a study conducted by Padmaja et al (1994) showed that the protein content of cassava decreased from 2.36g/100g to 1.6 g/100 g during fermentation. Conversely in a study by Babalola (2012), on soybean fermentation showed that the protein composition of the soybean increases after fermentation, whereas fat content of cassava decreased after fermentation.

Total polyphenols in the Sweet lime peel vinegar indicates that the fruit peel yields more polyphenols than the pulp. Polyphenols are potent inhibitors of LDL oxidation and this type of oxidation is considered to be a key mechanism in development of atherosclerosis (Aviram et al., 2000). Quercetin has been reported to possess anticancer property against benzo(a)pyrene induced lung carcinogenesis in mice, an effect attributed to its free radical scavenging activity (Kamaraj et al., 2007). Thus sweet lime peel vinegar and sweet lime fruit-peel combo vinegar are valuable addition to the diet which contributes polyphenols and flavonoids. As both Sweet lime peel vinegar and Sweet lime fruit-peel combo vinegar are rich in B complex vitamins, it can be used for the treatment of B complex vitamins deficiencies.

Vitamin C content was 56.7mg in sweet lime peel vinegar and 95.6mg in sweet lime fruit-peel combo vinegar. The vitamin C content in 100g of Sweet lime fruit is 50 mg. Therefore the vitamin C content of sweet lime fruit-peel combo vinegar is higher than the Sweet lime peel vinegar. The absorption of non-haem iron found in the plants is enhanced by vitamin C (Iqbal et al., 2004). It can be observed from the Table 13b that the iron content of sweet lime peel vinegar and sweet lime fruit-peel combo vinegar are 10.2 mg and 5.45 mg respectively. Both the vinegar samples can be used as iron supplementation for anemia as they are rich in iron and vitamin C.

Sweet lime peel vinegar had vitamin E in traces but sweet lime fruit-peel combo vinegar had the traces of the vitamin. Vitamin K in both the samples was negligible.

The dietary fibre content in sweet lime peel was 6.75 g and in sweet lime fruit-peel combo vinegar it was 4.34 g. Vinegar typically has 4-18% acetic acid by mass (Ismael., 2013). The acetic acid content of sweet lime peel vinegar was 19.2g and sweet lime fruit-peel combo vinegar was 38.4g. Acetic acid content in both vinegar samples was higher than the standard commercial vinegar.

3.2 Analysis of physicochemical properties

The results of the physicochemical properties viscosity, density, refractive index and acid value measured are presented in table 3 b.

3.3 Formulation of recipes using sweet lime fruit-peel combo vinegar

The formulated sweet lime fruit-peel vinegar was incorporated into a variety of dishes to increase the polyphenols, flavonoids, vitamins and dietary fibre so as to benefit general health and to treat specific conditions like Diabetes Mellitus, Cardio Vascular Diseases and Obesity. As the sweet lime peel was bitter in taste sweet lime fruit-peel combo vinegar was used. Sweet lime fruit-peel combo vinegar was selected as it had similar nutrient composition of sweet lime peel vinegar and better antimicrobial activity than sweet lime peel vinegar. Twenty recipes were formulated and standardized using sweet lime fruit-peel combo vinegar. Sensory evaluation for these recipes was done by the panel of judges. The score obtained for the sensory qualities were assessed and compared such as appearance, color, texture, flavor, taste and overall acceptability.

Table 3b. Analysis of physicochemical properties

Physical property	Sweet lime peel vinegar	Sweet lime fruit-peel vinegar
Viscosity	521 cps	545 cps
Density	1.084	1.04
Refractive Index	1.33	1.33
Acid value	85.15	223.5

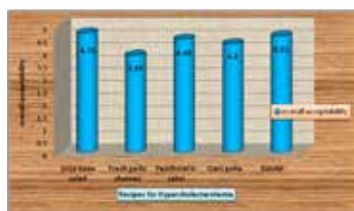


Figure 1. Overall acceptability of recipes for Hypercholesterolemia

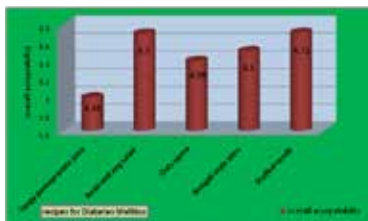


Figure 2. Overall acceptability of Recipes for Diabetes Mellitus

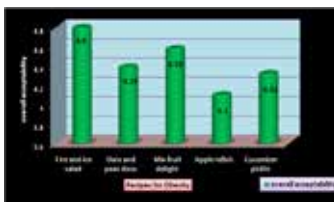


Figure 3. Overall acceptability of recipes for obesity

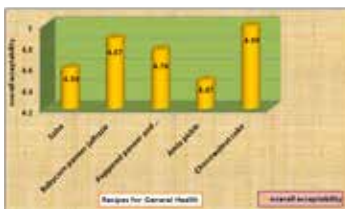


Figure 4. Overall acceptability of recipes for General Health

4. CONCLUSION

The results indicate that the sweet lime peel vinegar and sweet lime fruit-peel combo vinegar are nutritionally better than commercial vinegar. The newly formulated sweet lime peel vinegar and sweet lime fruit-peel combo vinegar are rich in vitamin A, B complex vitamins, vitamin C, iron and folate. It also contains bioactive components such as flavonoids and polyphenols which are potent anticarcinogenic compounds. Therefore it can be put to use nutritionally and therapeutically. Also the addition of sweet lime fruit-peel combo vinegar enhanced the recipes taste and gave a distinct flavor. There is a need to improve the physicochemical properties of the vinegar preparations as it more viscous, denser than the commercial vinegar.

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