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Development of Functional Drink from The Leaves of Moringa Stenopetala

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ABSTRACT

Moringastenopetalais a tree in the Moringa genus of flowering plants, native to Kenya and Ethiopia (southern part). It can be harvested all year round and plays a vital role for household food security, as source of income, medicine, fodder, fuel for the people in thatregion. It has large edible leaves reported to have high amounts of essential amino acid with the right balance, as well as high amounts of minerals and vitamins. Moringa is said to be the new hope in efforts at minimizing malnutrition and various related ailments. Now-a-days the demand for functional foods is on the rise. Our project work aims in exploiting the potential of *Moringastenopetala* towards the development of functional drink. Mango, Avocado, carrot, ginger and lemon will be used as natural additives to enhance its taste and appearance. The developed drink will be analyzed for it's proximate, sensory and shelf life analysis.

Keywords: Moringastenopetala, Functional drink, Malnutrition, Proximate, Shelf life.

INTRODUCTION

Moringastenopetala, commonly called the cabbage-tree (along with thirteen other species), is a tree in the *Moringa* genus of flowering plants, native to Kenya and Ethiopia (southern part). The tree is popularly known as shifara in Ethiopia. *Moringasteneopetala* is used for food, fodder, shade, windbreak, cash and medicine. It is a contingency crop in frequently drought-affected lowland areas with its high yielding capacity under drought condition and it can be harvested all year round. It plays a vital role for household food security, as source of income, medicine, fodder, fuel and shade tree all year round.

Table1.1 *Moringastenopetala*-Scientific classification

Kingdom:	Plantae
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Brassicales
Family:	Moringaceae
Genus:	*Moringa*
Species:	M. stenopetala

Table1.2 Proximate composition of *Moringastenopetala* leaves (g/100 g) dry weight basis

Carbohydrate	49.8
Protein	10.6
Fat	5.45
Crude fiber	20.8
Ash	13.4
Energy	290.6 kcal

Moringa stenopetala- Distribution & Uses

Many parts of the plant have been used in medicinal preparations. Whole plants have been used as living hedges, fences, and windbreaks. The wood is very soft; useful for paper but makes low grade firewood and poor charcoal. The crushed seeds are used as a coagulant similar to the chemical alum. *Moringastenopetala* has large edible leaves and seeds and is more drought- but less freeze-resistant than *Moringaoleifera* Freezes may cause it to die back to ground level, where new sprouts may be produced.

Moringastenopetala has also lushest green foliage and continues to grow during exceptionally long dry seasons. It develops into a round shrub-like tree and has been grown as an ornamental in private gardens in Kenya, reaching a height of 10-12 m and a trunk diameter of at least 2-3 times as that of *Moringaoleifera* in Sudan. In Ethiopia, *Moringastenopetala* grows wild in elevations between 1000 and 1800 m, and it will grow in up to 2000 m.

Traditional communities use the plant for multiple purposes such as source of food and medicine. The nutritional and medicinal importance of *Moringastenopetala*have been tested and confirmed by several researchers in different scientific studies. Hence, *Moringastenopetala* is the promising tree that can supplement the nutritional needs of malnourished peoples of all ages including children and women, especially in developing countries. The uses of the *Moringastenopetala* tree are almost endless, as it supplies a leafy green, edible flower buds and blossoms, edible seed pods, seeds that can be effectively used to purify water, and branches that make excellent mulch.

In Gamo-gofa region, immature leaves of *M. stenopetala* are part of the stable diet of the population. Kurkurfa, a paste prepared from *M. stenopetala* and cereals such as sorghum, maize, millet and barley is perceived as a delicacy among people in gamo-gofa region.

Functional foods – Definition and Importance

A functional food can be: an unmodified natural food; a food in which a component has been enhanced through special growing conditions, breeding, or biotechnological means; a food to which a component has been added to provide benefits; a food from which a component has been removed by technological or biotechnological means so that the food provides benefits not otherwise available; a food in which a component has been replaced by an alternative component with favorable properties; a food in which a component has been modified by enzymatic, chemical, or technological means to provide a benefit; a food in which the bioavailability of a component has been modified; or a combination of any of the above (Pravst 2012).

Over the last decade, demand for "healthy" foods and beverages has increased in many parts of the world (Ozen *et al.*, 2012). The idea of health-promoting foods is not new: Hippocrates wrote 2400 years ago "Let food be thy medicine and medicine be thy food" (Otles and Cagindi 2012), and Asian communities were familiar with the concept of functionality of food products and herbs. Nowadays, the advances in scientific research support the idea that diet may fulfill nutritional needs and exert a beneficial role in some diseases (Otles and Cagindi 2012). The various stakeholders have perceived the economic potential of functional food products as an important part of public health prevention strategies. Some authors reported that an annual reduction of 20% in health-care expenditure is possible through widespread consumption of functional foods (Sun-Waterhouse 2011).

Nowadays, the range of functional foods includes products such as baby foods, baked goods and cereals, dairy foods, confectionery, ready meals, snacks, meat products, spreads, and beverages (Ofori and Hsieh 2013). In particular, beverages are by far the most active functional foods category because of (i) convenience and possibility to meet consumer demands for container contents, size, shape, and appearance; (ii) ease of distribution and better storage for refrigerated and shelf-stable products; (iii) great opportunity to incorporate desirable nutrients and bioactive compounds without the loss in nutrients content (Sanguansri and Augustin 2009; Wootton-Beard and Ryan 2011). The different types of commercially available products could be grouped as follows: (1) dairy-based beverages including probiotics and minerals/ω-3 enriched drinks, (2) vegetable and fruit beverages, and (3) sports and energy drinks.

Statement of the problem

There are different kinds of problems faced by Human beings in this world. One of the major problems is malnutrition. This Malnutrition leads to poor mental and physical condition, causes disease and ill health and finally results in death. There has also been recent rise in non-communicable diseases such as cardiovascular disease, cancer, diabetes, and obesity, in the country. These are described as the greatest killers of the present time, as a result of the unhealthy lifestyle choices including fast food, beverages etc. Considering the potential benefits of *Moringastenopetala*, it can be developed into a functional drink, thereby reducing malnutrition and the risk of non-communicable diseases.

General Objective

To develop *Moringastenopetala* leaves based functional beverages

Specific Objectives

- To prepare *M. stenopetala* leaf aqueous extract
- To find out the suitable vegetables (carrot) & fruits (mango, avocado) for blending with *M. stenopetala* leaves
- To Characterize the developed product- proximate, sensory & shelf life studies

Significance of the Study

Moringa is said to be the new hope in efforts at minimizing malnutrition and various related ailments. The leaves of this plant have been reported to have high amounts of essential amino acid with the right balance, as well as high amounts of minerals and vitamins. Anecdotal evidence from communities that use Moringa as food and herb, suggest that the leaves do not only provide good nutrition, but they are also believed to suppress diabetes and hypertension in adults. Moringa leaves believed that it contain more vitamin A than in carrots, more calcium than in milk, more iron than in spinach, more vitamin C than in oranges, and more potassium than in bananas, and that the protein quality of Moringa leaves rivals that of milk and eggs. Beverage extracted from moringa has medicinal value which provided health. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, anti-inflammatory, antihypertensive, antidiabetic and are being employed for the treatment of different ailments in the indigenous system of medicine.

Scope of the Study

Nutraceutical foods and beverages have physiological as well as nutritional importance against the risk of chronic diseases.Processing of medicinal plant components may become a big industry due to their vastapplication in food and beverage industries. The nutritional awareness and the consumer's demand for the healthier lifestyle have created immense demand for the evolution offunctional foods and beverages. Usually, the medicinal plant juices are not preferred by the consumers due to their bitter and unpleasant taste but no one deny their nutritional and medicinal benefits. Keeping in the view of consumer demand in the future, this study is designed to make nutraceutical beverage by blending of *Moringa*with avocado, carrot, mango, lemon and ginger as natural additives to enhance their consumer acceptability.

MATERIALS AND METHODS

Source of raw material& chemicals

The raw materials used for this study will be purchased from the local market of Arba Minch Town, Ethiopia. Chemicals used for this study will be obtained from the laboratory of Chemistry, Abaya campus, Arba Minch University.

Juice extraction

Preparation of Moringastenopetala leaf juice

One hundred gram (100 g) of fresh *Moringastenopetala* tender leaves purchased from market will be washed thoroughly in tap water, rewashed in sterile solution (mixture of equal volumes of 5% citric acid and sodium metabisulphite) and washed again with distilled water. It was blanched in hot water, 90^{o}C for 10 minutes (Potter, 1973) and slurred using a clean commercial laboratory blender with two hundred milliliters (200 ml) of treated water (boiled at 100^{o}C and cooled) at low speed of 18,000 rpm for 2 mins. The volume of water used in the extraction was determined after preliminary experiments on water: weight of leaves ratio for blending. Finally, the slurry was filtered using a sterilized cheese cloth to obtain the extract. The extract was centrifuged (refrigerated centrifuge) to obtain a clear juice extract which was pasteurized at 62^{o}C for 30 minutes (Aurand *et al.*, 1987)

Fruit juice

Fresh ripe avocados and mangos was washed thoroughly in tap water, peeled and sliced (2 cm thick) with a clean knife to ensure easy blending. It was blanched in hot water, 90^{o}C for 10 minutes (Potter, 1973). The sliced mango was pulped using a clean laboratory blender at low speed of 18,000 rpm for 2 mins. It was filtered using a sterilized cheese cloth to obtain the juice. The juice was pasteurized at 62^{o}C for 30 minutes (Aurand*et al.*, 1987).

Vegetable juice

Fresh carrots was cleaned and sliced (0.5 cm) using a clean knife to ensure easy blending. It was blanched in hot water, 90^{o}C for 10 minutes (Luh and Woodroof, 1975). One hundred (100) grams of the sliced carrot was slurred in two hundred milliliters (200 ml) of treated water (boiled at 100^{o}C and cooled) in laboratory blender at low speed of 18,000 rpm for 2 mins. The slurry was filtered using a sterilized cheese cloth to obtain the juice. The juice was pasteurized at 62^{o}C for 30 minutes (Aurand *et al.*, 1987).

Flavor extraction

Natural ginger distillate

Ginger (*Zingiberofficinale*) rhizomes was thoroughly washed, cleaned and sliced (0.5 cm) using a sterilized knife. Hundred (100) grams of the sliced ginger was slurred in two hundred milliliters (200 ml) of treated water (boiled at 100^{o}C and cooled) in laboratory blender at low speed of 18,000 rpm for 2 mins. The slurry was filtered using a sterilized cheese cloth to obtain extract. The extract was distilled using steam distillation. The distillate was collected and used as a natural ginger flavor.

Treatment plan for moringa based vegetable drink (250 ml)

Treatment	Moringa extract	Vegetable juice	Sugar syrup	Citric acid
T1	50 ml	50 ml	50 ml	0.25 g
T2	50 ml	70 ml	50 ml	0.25 g
T3	50 ml	90 ml	50 ml	0.25 g
T4	50 ml	100 ml	50 ml	0.25 g

Treatment plan for moringa based fruit drink (250 ml)

Treatment	Moringa extract	Fruit juice	Sugar syrup	Citric acid
T1	50 ml	50 ml	50 ml	0.25 g
T2	50 ml	70 ml	50 ml	0.25 g
T3	50 ml	90 ml	50 ml	0.25 g
T4	50 ml	100 ml	50 ml	0.25 g

Proximate Analysis

Ash

The dry ashing method in accordance with AOAC (1990) was used in this determination using Muffle Furnace Weigh accurately about 5 gm. of sample in a tared silica / platinum dish. Char the material carefully on a burner and transfer the dish to a muffle furnace and ash at a temperature of 550 ^{o}C until the ash is free of carbon. Heat the dish again at 550 ^{o}C for 30 minutes Cool in a desiccator and weigh. Repeat this process of heating for 30 minutes, cooling in a desiccator and weighing until the difference between two successive weighing is less than 1 mg. Record the lowest weight and results recorded in grams (g).

pH

The pH of ten milliliters (10 ml) of juice was determined using a pH meter

Total Soluble Solids

The total soluble solid of ten milliliters (10 ml) of juice was determined using a Refractometer

Titratable Acidity

To determine the Titratableacidity in given sample of juices, take about 100ml of fruit juice into a conical flask (250 ml). Pipette out 10ml of filtered juice into a conical flask (250ml). Dilute to 80ml using distilled water. Then the mixture was titrated against 0.1M NaOH using 1% phenolphthalein as indicator. The Acidity is calculated as acetic acid (%).

Mineral Analysis

A wet digestion method was used to eliminate all organic matter from the sample before the sample was analyzed for the various minerals. About 1 ml of the sample is measured into a 250 ml beaker. Twenty five milliliters (25 ml) of concentrated HNO3 is added and the beaker is covered with a watch glass. The sample is digested with care on a hot plate in a fume chamber until all the organic matter had been oxidized (20-30 mins). The pale yellow solution is cooled and 1ml 70% HClO4 is added with care. Digestion is continued until the solution was almost colorless (until all the HNO3 was removed). The solution is then cooled slightly after the digestion process, and about 30 mldistilled water is added and allowed to boil for about 10mins then filtered when hot through No. 4 What man filter paper into a 100 ml volumetric flask. The beaker is washed well with distilled water and filtered. The flask is then cooled and made up to the 100 ml mark. This solution was used for all the mineral analyses. The following minerals; Magnesium (Mg), Calcium (Ca), Potassium (K) and Iron (Fe) was determined using the Atomic Absorption Spectrophotometer and results recorded in milligram (mg).

Preparation of standard solutions for AAS

Stock solutions were prepared from analytical grade granulated metals of high purity (99.99%). 0.1g of metal powder was weighed and transferred into 1000ml volumetric flasks. Then stock were prepared by dissolving of Fe, Mg, Ca and K metal powders in 5ml $NHO_{3,}$ 10ml of distilled water and diluted by distilled water to give 1000 mg/L. For quantitative purposes, working standard solutions of the elements namely calcium (Ca), potassium (K), magnesium (Mg) and iron(Fe) were prepared from the stock standard solutions containing 1,000 mg/L of an element in 2 *N* nitric acid. By took different concentration from stock solutions. 10ppm for Fe and 50pmm for Mg, Ca and K using dilution formula.

$C_1V_1=C_2V_2$

Where;
C_1=Original concentration
V_1=Original volume
C_2=New concentration
V_2=New volume

Serial dilution preparation

Serial dilution prepared from working stock solutions by diluting its concentration. Five serial of different concentration of equal interval was prepared for each element. Then absorbance was determined by using AAS.

Calibration standards for AAS analysis

Standards prepared from stock solutions were used to establish AAS calibration curves and in turn used to determine the concentrations of selected essential elements in the specified plant Samples and absorbance of analytes (samples) and blank solution were determined.

Microbial Analyses

The juice was tested for their microbiological safety by determining the Total Plate Count TPC), Yeasts /Moulds, Total Coliforms and Staphylococcus aureus using proceduresoutlined in the Quality Assurance Procedure Manual of Ghana Standards Board, Okponglo, Legon.For microbial analyses serial dilution neutral agar technique was used. The juice was used directly for analyses microbial, while cheese was serially diluted in saline solution. Juice sample solution was incubated at 37°C for 24 hrin an aerobic condition. In the serial dilution neutral agar plate technique, 10ml of a stock solution was added to 9 ml water blanks to form a microbial suspension. 10ml serial dilution of 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} was pipetted into 9ml water blanks. 10 ml of each dilution to neutral agar plates were inoculated and incubated at 37^{0}C for 24 hrs for microbial growth. The plates were observed for appearance of colonies.

RESULT AND DISCUSSION

Proximate composition of Moringastenopetala leaf powder

The Moringastenopetala leaves collected were allowed to shade dry for 3 days at room temperature. Once its completely dried, leaves were powdered by using high speed laboratory blender. The proximate analysis for leaf powder was carried out using standard methods and the data has been represented below

Table. 3.1 Proximate composition of Moringastenopetala leaves

Parameter (g/100g) dry wt basis	
Carbohydrate	50.68±0.56
Protein	10.07±0.23
Fat	05.65±0.06
Crude fiber	21.88±0.65
Ash	11.70±-0.37
Minerals- (mg/100g)	
Sodium	398.2±2.1
Potassium	412.6±3.8
Phosphorus	063.4±1.7
Calcium	687.5±3.5
Iron	3.56±0.12
Zinc	0.58±0.03

It has been observed from the proximate analysis that the carbohydrate content was found to highest followed by crude fiber and protein. The above result was in accordance with the value reported in literature by Abuye et al., 2003. Among mineral composition Calcium was found to be highest followed by potassium and sodium. The high calcium level in M. stenopetala leaves suggests that oxalic acid would occur as insoluble ca salts in the leaves. The reported values were similar to the values reported in the previous studies.

Abuye C, Urga K, Knapp H, Selmar D, Omwega AM, Imungi JK and Winterhalter P (2003). A Compositional Study of Moringastenopetala leaves. East African Medical Journal; 80 (5): 247-252.

Formulation of Moringa beverage

As much as the objective was to develop a Moringa leaf juice, the practical realities of an agreeable product color and the need for an appropriate sweetener demanded the inclusion of other ingredients to serve those functions. Similarly, carrot extracts were also used to add color to the product, since preliminary tests indicated that the green Moringa juice color was not acceptable to consumers. For further enhancing the odor, flavor and taste lemon and ginger extract were added as additives in small amounts. The combinations that have been used for the preparation of juice was mentioned in the methodology part. Sensory Evaluation

Optimization in sensory evaluation is defined as a procedure for developing the best possible beverages. Although an optimal formation should maximize consumer acceptance, it is impossible to develop a product with all sensory qualities that would satisfy consumers in most applications.

The sensory analysis of samples were performed by untrained panelists (students of Industrial chemistry) by using seven point hedonic scale. The panelists were explained very well about the analysis and report was generated based on the scores given by panelists. The data for sensory evaluation has been represented below Sensory analysis of Moringa-Carrot juice blend

Treatment	Color	Flavor	Mouthfeel	Taste	Overall Acceptability
Control	5.4±0.21	4.8±0.32	5.2±0.34	4.5±0.21	4.97
T1	6.7±0.23	6.7±0.21	6.8±0.33	6.8±0.34	6.75
T2	6.3±0.16	6.4±0.32	6.3±0.25	6.5±0.27	6.38
T3	5.7±0.14	5.9±0.18	6.2±0.27	5.5±0.22	5.83
T4	6.8±0.18	6.7±0.20	6.8±0.32	6.8±0.37	6.78

Sensory analysis of Moringa-Avacado juice blend

Treatment	Color	Flavor	Mouthfeel	Taste	Overall Acceptability
Control	5.4±0.23	4.8±0.29	5.2±0.28	4.5±0.24	4.97
T1	6.8±0.21	6.7±0.22	6.7±0.32	6.8±0.31	6.75
T2	6.4±0.17	6.3±0.35	6.3±0.24	6.5±0.25	6.36
T3	5.6±0.15	5.8±0.17	5.9±0.26	5.4±0.21	5.68
T4	6.8±0.19	6.8±0.22	6.8±0.30	6.8±0.35	6.8

The taste of the juices was rated by researchers from like slightly to dislike slightly. The highest for taste was obtained when avocado and carrot were at its highest level. The taste of the juice was scored the highest at minimum Moringa levels and was disliked slightly at maximum moringa level.

The first impression of the quality and acceptability of any food is judged by its color. The panelists score in range of "good" for all treatments except control. The highest score for color was observed in T4(6.8) for moringa-carrot juice followed by T1, T2 and T3as 6.7, 6.3 and 5.7 respectively.The highest score for color was observed in T1 & T4 (6.8) for moringa-avocado juice followed by T2 and T3 as 6.4 and 5.6 respectively.

Aroma and flavor has great impact on the product acceptability.The highest score for flavor was observed in T1 &T4(6.7) for moringa-carrot juicefollowed by 6.3 in T2and 5.8 in T3. The highest score for flavor was observed in T4 (6.8) for moringa-avocado juice followed by 6.7 in T1, 6.3 in T2 and 5.8 in T3. The highestacceptability of T1 mightbe due to more suitable proportion of juice blends, ultimately improving the quality andgives attractive colors and aromas in the finished product (Vazquez-Araujo *et al*., 2010).

Vazquez-Araujo, L., Chambers, I. V., Adhikari, K., & Carbonell-Barrachina, A. A. (2010). Sensory and physicochemical characterization of juices made with pomegranate and blueberries, blackberries, or raspberries. Journal of food science, 75(7), S398-S404.

Several studies have shown that taste and mouthfeel are the major concerned factors in the acceptance and purchasing behavior ofconsumers while purchasing any food product (Urala&Lahteenmaki, 2003). Moreover, cultural values have alsobeen connected with human taste perceptions and hedonic responses. In present study moringa-carrot blended drink T1 & T4 scored highest (6.8) for taste and mouthfeel followed by T2 & T3. For moringa-avocado belnded drink T1 & T4 scored highest (6.8) for taste and mouthfeel followed by T2 & T3.

Urala N., Lahteenmaki L. (2003). *Reasons behind consumers' functional food choices*. Nutrition & Food Science,Vol. 33, Issue 4, pp. 148-158.

According to Aronson and Ebeler (2004), polyphenolsare major non-volatile components that contributeto mouth feel attribute or interact with volatile compoundsin the beverage. It can be observed from the Tables that mouth feel of beverage improved with increased concentration of moringajuice up to 50 in both the cases, while further increase in moringacontent reduced mouth feel due to bitterness. In overall acceptance, treatment T1 was found to be most acceptable in both moringa-carrot &moringa-avocado blends, whereas T3 was found to be least acceptable.

Aronson, J., Ebeler, S.E. (2004) Effect of polyphenol compounds on the headspace volatility of flavors.Amer J EnolViticult, 2004; 55:13-21.

Juice preparation and analysis

The best acceptable combination of T2 was chosen in both Moringa-carrot &Moringa-avocado blends based on the sensory evaluation studies and the juice was prepared for further analysis.

Physicochemical analysis of Moringa-carrotdrink

Treatment	pH	Acidity	TSS	Ash (%)
Control	5.05	0.175	13	0.013
T1	5.14	0.167	12	0.019
T2	5.23	0.161	11	0.024
T3	5.30	0.154	11	0.032
T4	5.74	0.147	10	0.046

Physicochemical analysis of Moringa-avocadodrink

Treatment	pH	Acidity	TSS	Ash
Control	5.05	0.175	13	0.013
T1	5.32	0.168	12	0.023
T2	5.43	0.162	12	0.037
T3	5.76	0.152	11	0.048
T4	6.07	0.149	11	0.059

Titratable acidity and pH is a parameter of the sourness of the product and it also reflects on the stability of the product with regards to deterioration during storage (Out *et al*., 2013). However, it was observed that mean value of pH increased from 5 to 6 in both the cases. Infusion of *Moringa*powder is slightly acidic due to the presence of oxalic, phenolic and chlorogenic acids. It has been observed that in both moringa-carrot &moringa-avocado juice blends with the infusion of carrot, avocado and other additives, th pH values gradually increased.

Acidity plays remarkable role in the flavor of a product. The mean values of total acidity decreased from 0.17% to 0.14% in both the cases. It was observed that with the increase in carrot, avocado percentage, titratable acidity of the blend decreased. Ash content represents the mineral content in food products (Akhter *et al.*, 2012). Ash content for both juice belnds was found to gradually increasing with increase in concentration of carrot & avocado. The results recorded was similar to the work conducted by Ahmed *et al*., 2013.

Otu, P.N.Y., Saalia, F. K., & Amankwah, E. A. (2013). Characterization of Fresh Moringaoleifera Beverage. Food Science and Quality Management,21(1), 26-33.

Akhter, S., Masood, S., Jadoon, S. H., Ahmad, I., &Ullah, S. (2012). Quality evaluation of different brands of Tetra Pak mango juices available in market. Pakistan J. Food Sci, 22, 96-100.

Proximate composition of Moringa-Carrot &Moringa-avocado juice blends

Parameter (g/100g)	Moringa-carrot juice	Moringa-avocado juice
Carbohydrate	5.32±0.06	5.10 ± 0.02
Protein	2.64±0.03	2.75 ± 0.04
Fat	1.65±0.02	2.63 ± 0.05
Water	88.87±0.15	85.62 ± 0.09
Minerals- (mg/100g)		
Sodium	67.2±0.17	68.31±0.23
Potassium	75.56±0.19	76.43± 0.15
Phosphorus	3.45±0.05	3.87±0.04
Magnesium	10.07±0.07	11.80 ± 0.05
Calcium	63.45±0.48	63.53 ± 0.36
Iron	1.68±0.02	1.59 ± 0.02
Zinc	0.08±0.01	0.075±0.01
Vit-c	198.26±0.21	200.62 ± 0.17

Carbohydrate

The carbohydrate content of 5.32 g & 5.10 g has been recorded for Moringa-carrot &Moringa-avocado juice blend respectively. However, both carrots and avocado juices have lower amounts of carbohydrate when compared with moringa leaf extract.

Protein

In the final composition protein content of 2.64 g & 2.75 g has been recorded for Moringa-carrot & Moringa-avocado juice blends. This may be due to low concentration of proteins found in carrot & avocado and the colloidal dimensional structure of proteins makes it uneasy to pass through semi permeable membranes according to Aurand and Woods (1973). Also some proteins are not water soluble and therefore could not have been extracted in the aqueous medium.

Aurand, L.W. and Woods, A.E. (1973). Food Chemistry. The Avi publishing Company, Inc, Westport, Connecticut, pp 143.

Fat

Fat is soluble in organic solvents like petroleum ether. The addition of fat from the avocado and carrot accounts has led to increase in fat content of the final composite juice of 2.63 g & 1.65 g respectively. The high content of fat in moringa-avocado blend may be due to high amount fat present in avocado.

Water

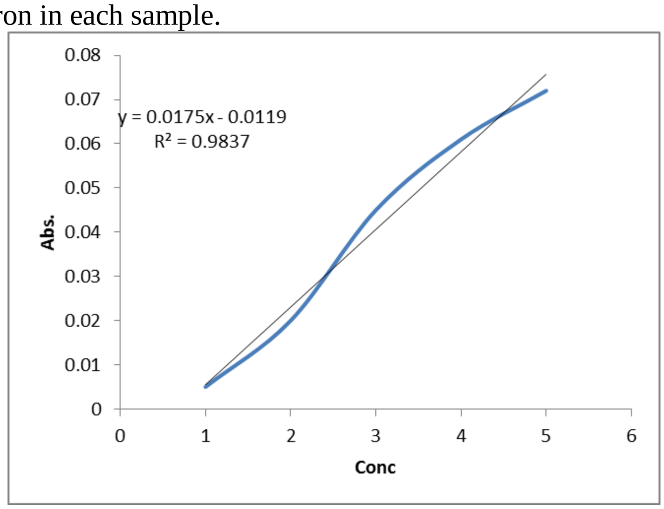
The total water content of the final juice was 88.87 g & 85.62 g for moringa-carrot & moringa-avocado juice blends respectively.

Minerals

The concentration of sodium, potassium, phosphorus, calcium, magnesium, zinc and iron were determined and the following result was obtained.The mineral analysis revealed that there was general reduction after extraction from leaves. However, a good amount of mineral content has been observed in the final juice blends.

The absorbance of samples were studied for each analyst and a model calculation used for determination of concentration of mineral is represented below

The following graph 1 with equation of $y = 0.0175x - 0.0119$was drawn for standard iron concentration and its absorbance and value of x was computed to determine unknown concentration of iron in each sample.



Graph 1: Iron absorbance versus concentration

From above graph the concentration of the sample determined as follow:

Moringa-carrot juice: $x = \frac{y+0.0119}{0.0175} = \frac{0.0175+0.0119}{0.0175} = 1.68ppm$

Moringa-avocado juice : $x = \frac{y+0.0119}{0.0175} = \frac{0.0159+0.0119}{0.0175} = 1.59ppm$

Iron is an essential nutritional element. Functions of iron include involvement in energy metabolism, gene regulation, cell growth and differentiation, oxygen binding and transport, muscle oxygen use and storage, enzyme reactions, neurotransmitter synthesis, and protein synthesis. Calcium is essential in the body for blood clotting, stabilizes blood pressure, contributes to normal brain function and bone health (Madukwe et al., 2013).A significant amount of Iron and calcium has been observed in both juice blends.

Madukwe E.U., Ezeugwu J.O and Eme, P.E. 2013. Nutrient Composition and Sensory Evaluation of Dry *MoringaOleifera*Aqueous Extract.International Journal of Basic & Applied Sciences IJBAS-IJENS Vol:13 No:03 100

Vitamins

Water – soluble vitamins, like riboflavin and particularly ascorbic acid is easily destroyed by heat, light, exposure to air, cooking in large amounts of water and alkalinity. However appreciable amount of vitamin C present in the both the juice blends showed that there was only minor loss in vitamin content.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Moringa leaf extract is rich in essential nutrients and is suitable in food supplementation. Moringa plant is drought resistant and grows all the year round. Hence it can serve as an economically nutrient rich option in the fight against micronutrient deficiencies and malnutrition. Juice is one of popular drink among consumers in Ethiopia and the choice of juice as a beverage is usually determined by its color and taste, and consumers will try a new juice product if it meets their criteria.

In this study we have developed Moringa-carrot &Moringa-avocado juice blends through trial and error of addition of different concentration of additives (ginger, lemon).High amounts of Moringa extracts in the composite juice impacted negatively on its sensory acceptability. On the other hand high amounts of carrot and avocado juices strongly improved the scores of the sensory attributes.

The outcomes of the present study suggested that T1 and T2 formulations in both the cases was to be acceptable, whereas the ratio of 25 : 75 Moringa-Carrot & 25 : 75 Moringa-Avocado was proved as best product in terms of color, aroma, flavor, taste, mouth feel and overall acceptance.

This research, ultimately resulted in the development of a functional moringa-carrot & moringa-avocado juice blends with good consumer acceptability. However, further studies are suggested to probe this nutraceutical drink for different bio-active moieties that may prove effective against different chronic diseases.

Comparing the nutrient composition of some blended juices from literature with the final composite juice, the latter is a more nutritious beverage considering the protein, Iron, vitamin A and C content.

Recommendations

It is hereby recommended that further studies may be carried out to investigate and extend their shelf life, to verify the medicinal potential of the juice, particularly for diabetic and hypertensive conditions and study on packaging effect should be carried out to determine the type of packaging that can best prevent interaction between the environment and product. Considering the aforesaid health benefits further efforts should be made to package and commercialize Moringa juice blends.

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