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NUTRITIONAL AND SENSORY EVALUATIONS OF CITRUS DRINKS SUPPLEMENTED WITH KHAT (CATHA EDULIS) POWDER: THE CASE OF KHAT GROWN IN HARARGHE, EASTERN ETHIOPIA

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Key words: Anti-nutrients, Awaday, Galamso, Khat, Kobo, nutritional, sensory attributes

Abstract

Khat is a perennial shrub grown in most part of Ethiopia. It is socially favoured for its stimulating effects and may be beneficial if it were blended with citrus drinks and available to the community in use. Therefore the main objectives of this study were to analyse the nutritional contents and to evaluate citrus drinks supplemented with Khat powders. The study material consisted of three Khat types namely Awaday, Galamso and Kobo collected from three places as their name indicated. The clean and ripen mango and orange fruits were obtained from the open market of Harar. Khat types were sorted, dried and pounded and the powder was mixed with water and filtered by using muslin cloth separately. The extracted juice (mango and orange) were blended with filtered Khat (Awaday, Galamso and Kobo) in the ratios of (100%:0%, 97.5%:2.5%, 95%:5%, 92.5%:7.5%), respectively. The produced juices were then ready for sensory evaluation. The nutritional and sensory data were, respectively, analyzed using one and two ways ANOVA. The results revealed that significant differences were observed in nutritional composition among khat types. The highest total ash was obtained for Galamso (6.19%) and followed by Kobo (6.5%) khat types. The highest protein content was recorded by Awaday (14.41%) but the lowest protein content was recorded by Galamso (12.54%) followed by Kobo (12.68%) khat types. Ca content was highest in Awaday (193.59 mg/100g) and lowest in Galamso (150.94 mg/100g) khat types. The Zn contents ranged from 3.47 mg/100g to 4.03 mg/100g for Awaday and Kobo, respectively. Tannin concentration ranged from 111.12 mg/100g for Kobo to 126.16 mg/100g

for Awaday. The sensory attributes scores of all khat types at all ratios of mango and orange were between 4.9 and 6.8 indicating that the juices produced were between liked slightly to liked very much on seven hedonic scale. Although the three Khat sources were different in nutritional contents, the juice drinks were well accepted by the panellists.

1. Introduction

Khat (*Catha edulis*), is an evergreen perennial shrub plant that belongs to the Celastraceae family which contains 60–70 genera and 850–900 species. It is an erect, evergreen, glabrous shrub or tree 2–25 m high with reddish stems, shiny green leaves and white flowers. There are several names for the plant, depending on its origin: chat-Ethiopia, qat-yemen, and qaad/jab- Somalia [1]. The most favoured part of the khat is its leaves, particularly the young shoots near the top. Among the various compounds in the plant, the two phenyl alkyl amines namely cathine and cathinone seem to account for most of the stimulating effect when ingested users get feeling of well-being mental alertness and excitement then after effects are usually numbness and lack of concentration [2].

Khat is mainly limited to, until recently, in Ethiopia and Yemen where it has been cultivated for a very long time. However, recently its cultivation has been spread to most of the eastern African countries and further to South Africa [3]. In Ethiopia, khat is grown in most parts of the country. There is an ever-growing demand both for domestic consumption and for the export market. Most of the exported khat is grown in the eastern part of the country and mainly exported to the neighbouring and the Middle East countries, and in recent years, the market for khat has grown to Europe and America [4]. Report indicates that over 20 million people in the Arabian Peninsula and East Africa chewed this plant daily [5]. Khat use is widespread and cultivated in most parts of Ethiopia, where its use is socially sanctioned and even prestigious [6]. To date, it is a common practice among many individuals particularly in the eastern, southern, and some parts of northern parts of the country. Because of increase in population, khat production and consumption is increasing in an alarming rate.

In Ethiopia, khat prefers mid altitudes ranging from 1500 to 2100 m in almost all regions of the country. Khat is grown on well-drained soil [7]. From planting a stand of khat to regular harvesting normally takes 2–3 years. It is harvested by breaking off the young branches from the main branches and trimming it to about 40 cm. Young and soft shoots are detached with

the bare hands, while hardy shoots are cut off by hand tools. Depending up on the geographical location, the variety of khat is enormous. They differ in colour, size and height of the leaves and size and height of the plant as a whole and the most favoured part of the plant is its leaves, particularly the young shoots near the top [8]. In most regions in Ethiopia best time for harvest is the rainy season June–August with secondary harvest in November – February for irrigation users [7].

In Ethiopia, the plant is marked under different names where some of them are commonly exported to the neighbouring countries while the remaining is chewed by the local people around. Most names of khat are derived from the name of the place where the plant is growing. Example, Awaday khat is cultivated around Awaday, Galamso khat is cultivated in Galamso, Bahir Dar khat is cultivated in Bahir Dar, etc. Hararghe is the principal region of khat cultivation in particular in east and west Hararge zones: Deder/Kobbo, Awaday and Galamso districts with Awaday town as the most important khat market [7]. One important reason for the expansion of khat production in Hararghe area is that the khat–maize intercropping system is three times more profitable per hectare than the maize mono-cropping. It is also less risky to grow than cereals and coffee because it is less vulnerable to drought [7]. Sorghum, corn and sweet potatoes are generally can be intercropped with khat. This is possible because the khat trees are so spaced that they leave much area between plants [9].

Khat plant is highly significant for the social and cultural life of the people where it has been used for several centuries. It is used to welcome and entertain guests both in happy occasions (wedding ceremonies) and on sad occasions (gatherings) at homes of persons after burials [10]. In addition, many people believe that it helps them to get relief from fatigue, increase alertness, and reduce the sensations of hunger. It also brings feeling of elation, improves ability to communicate and self-confidence [11]. On average, almost 70% of households in Yemen and 50% in Djibouti use khat [12], and more than 30% of Ethiopians have been reported to use *khat* [6]. It is a major source of income besides being chewed for its stimulating effect. The most favoured part of the plant is its leaves, particularly the young shoots near the top of the plant. However, leaves and stems at the middle and lower sections are also used. *Khat* is chewed for its stimulating property. This is due to the presence of the phenylalkylamines in the plant [5].

To date, extensive work has been done with respect to phytochemical studies and pharmacological as well as social effects of *khat*. However, no adequate investigations have been made and documented regarding the nutritional and anti-nutritional contents of *kha*t

grown in different agro - ecological areas. In addition, although the most common way of obtaining the stimulating effect of *khat* is by chewing fresh leaves and soft twigs, consuming in the form of dried and pounded and mixing with other fruit products particularly in the form of juice is not known/ accustomed. Therefore, this study was initiated to analyse the nutritional contents of *khat* categorized under different name and grown in different agro-ecological zones and prepare and evaluate a khat powder supplemented with citrus drink.

2. Materials and Methods

2.1. Experimental Site

The laboratory analysis, product development and sensory evaluation were conducted at the Central laboratory and Department of Food Science and Postharvest Technology, Haramaya University, Ethiopia.

2.2. Experimental Materials

For the purpose of the study, fresh khat samples were collected from Awaday, Galamso, and Kobo of Hararghe zones. It is because of khat grown in these three places are known by their high demand and the areas are known by their high khat production in the Hararghe. Furthermore, the study contains ripen and clean mango and orange which obtained from Harar open market.

2.3. Sample preparation

Each khat sample was collected in a pre-cleaned polyethylene bag. It was sorted by cutting the tender leaves and twigs which can be used for chewing purpose. The sorted samples were washed thoroughly with clean water and dried using an oven drying method at 70°C for 72 h (until constant weight). Dried khat samples were finely ground using a mortar and pestle and the flour was sealed in plastic bags and stored in a refrigerator temperature (4^{O}C) until analysis that meant for nutritional analysis.

2.4. Nutritional Analysis of khat

Moisture content was determined by drying the samples at 105 ^{0}C for 3 hours. Crude protein content was determined by *micro*-Kjeldahl method (digester F30100184, SN 111051, VELP Scientifica; distiller F30200191, SN 111526, Europe) of nitrogen analysis (% protein = %N x 6.25) by taking about 1.0g khat flour [13] using urea as a control in the analysis. Ash content was determined after carbonization of about 2.0g khat Khat flour and ashing (525^{O}C) in a muffle furnace (Model: MF 120, SN: 04 - 1524, Ankara-Turkey) until ashing was complete [13]. Crude fiber content was determined by taking khat flour sample (about 3.0g) as a portion of carbohydrate that resisted sulfuric acid (1.25%) and NaOH (1.25%) digestion

followed by sieving (75 μm), washing, drying and ignition to subtract ash from fiber [13]. Carbohydrate content of khat was determined by subtracting the above proximate composition values from 100 using formula of

$$C(\%) = 100 - (\%M + \%A + \%F + \%FB + \%P)$$

Where: C(%), % M, % P, % F, % Fb and % A are percentage of carbohydrate, moisture content, protein, fat, fiber and ash content respectively.

The concentrations of Ca, Mg and Zn in khat sample were determined by flame atomic absorption spectrophotometer (Buck Scientific Model 210 VGP, East Norwalk, USA) using an air -acetylene flame. Quantitative estimation of tannins was carried out using the modified vanillin–HCl method [14]. A 200 mg sample was extracted using 10 mL of 1% (v⁄v) concentrated HCl in methanol for 20minutes in capped rotating test tubes. Vanillin reagent (0.5%, 5 ml) was added to the extract (1 ml) and the absorbance of the colour developed after 20 minutes at 30^{o}C was read at 500 nm. A standard curve was prepared expressing the results as catechin equivalents, i.e. amount of catechin (mg 100 g-1) which gives a colour intensity equivalent to that given by tannins after correcting for blank. Then, tannin content was calculated and expressed in mg 100 g-1.

2.5. Preparation of khat powder mixed with fruit juices

The collected khat samples were sorted by cutting the tender leaves and twigs which can be used for chewing purpose. The sorted samples were washed thoroughly with clean water and dried using an oven drying method. Dried khat samples were finely ground using a mortar and pestle. Khat powder was mixed with water and filtered by using muslin cloth. Furthermore, the ripe mango and orange fruits were selected by inspection methods and washed by water. The cleaned sample of fruits were peeled by using a sharp knife and sliced for juice extraction. The juice was extracted separately from each fruit by using a juice extractor and filtered by muslin cloth. Finally, the extracted juice was blended with filtered khat in the ratios of (100%:0%, 97.5%:2.5%, 95%:5%, 92.5%:7.5% respectively. The produced juices were then ready for sensory evaluation.

2.6. Sensory quality evaluation

Sensory evaluation of the khat powder mixed with fruit juices (mango and orange) separately in different proportions were evaluated using 50 Khat chewers and 50 non Khat chewers as panellists. The panellists were selected from staff and graduating class of students in the Department of Food Science and Postharvest technology. The sensory attributes: taste, colour, flavour, aroma, and stimulation were evaluated by 7 point hedonic scale rating from 1

(dislike very much) to 7 (like very much). Soon before the test session, orientation was given to the panellists on the procedure of sensory evaluation.

2.7. Experimental Design and Data Analysis

The nutritional analysis of khat samples and the sensory evaluation were undertaken in triplicates. Completely Randomized design (CRD) (for nutritional data) as well as randomized complete block design (RCBD) (for sensory scores) experimental designs were used. Analysis for the nutritional data was carried out using one way analysis of variance (ANOVA) using SAS statistical package (version 9.1, SAS Institute Inc., Cary, NC, USA). The sensory data was analysed using a two way ANOVA, where the variability emanating from the individual panellists was taken care of using the blocking principle. Means separation was done using the Fischer's least significant differences (LSD) at $p < 0.05$.

3. Results and Discussions

3.1 The Nutritional Content of Khat Types

The nutritional content and anti-nutritional content of khat was influenced significantly ($p<0.05$) by khat type (Table 1 and 2). The significant differences in nutritional and anti-nutritional contents among the khat types in this study could be attributed by different factors. Factors like nature of chemical and physical property of the soil, climatic condition of the region, application of fertilizers and cultural practices can affect the nutritional and anti-nutritional concentration of the plant.

Nutritionally, khat could contribute substantially to nutrients and mineral intakes. The result revealed that proximate composition of khat is higher than most of the vegetables and which is incomparable. The highest total ash was obtained for Galamso (6.19%) and Kobo (6.5%) khat type in statistical parity whereas the lowest was recorded for Awaday (5.59) khat type. The khat type significantly differed in protein yield. Awaday type of khat (14.41%) had recorded high percentage of protein. However, lowest protein content was recorded for Galamso (12.54%) and Kobo (12.68%) khat type. The protein content of khat is high and similar to that of cereal like sorghum. According to FAO [15] the crude protein of sorghum ranges 10.8–15.6%, which is almost comparable with khat protein obtained in this study.

Table1 Proximate compositions of khat

Khat type	Ash (%)	Moisture (%)	Protein (%)	Fat (%)	Crude Fiber (%)	Carbohydrate (%)
Awaday	5.59 ± 0.27^{b}	7.70 ± 0.17^{a}	14.41 ± 0.73^{a}	2.61 ± 0.07^{a}	4.31 ± 0.67^{c}	64.83 ± 0.31^{a}
Galamso	6.19 ± 0.51^{a}	7.43 ± 0.30^{ab}	12.57 ± 1.31^{b}	2.23 ± 0.10^{b}	7.56 ± 0.11^{a}	63.06 ± 1.94^{a}
Kobo	6.50 ± 0.36^{a}	7.12 ± 0.36^{b}	12.68 ± 2.21^{b}	2.70 ± 0.16^{a}	7.00 ± 0.29^{b}	62.80 ± 1.89^{a}
CV (%)	2.69	2.93	1.29	4.62	3.05	2.47

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

In respect of crude fat all the khat types, having values between 2.23 and 2.70 %. Highest fat was obtained for Awaday (2.61%) and Kobo (2.70%) khat type while the lowest was recorded for Galamso (2.23%) khat type. The effect of khat type significantly ($P < 0.05$) influenced the crude fibre contents of khat. The highest crude fibre was recorded for Galamso (7.56%) khat type but the lowest was obtained for Awaday (4.31%) khat type. Thus, the crude fiber of Galamso khat type was about 3.25% greater than that of Awaday khat type. The ash and crude fibre content of all khat type are high and incomparable to the vegetable like potatoes grown in East Hararghe. Potatoes grown in east Hararghe, Ethiopia, have ash (3.02-4.5%) and crude fibre (1.00-2.51%) which is lower than the Khat's ash and crude fibre obtained in this study [16]. Fibre has great roles in the prevention and treatment of diseases such as obesity, diabetes, cancer and gastro intestinal disorders [17]. There is also evidence that dietary fibre improves glucose tolerance and is therefore, it is beneficial in treating maturity pre-set diabetes [18]. The carbohydrate content of all the khat types was in the range of 62.8% and 64.83 %, in statistical parity. It revealed that as carbohydrate dominates the composition of khat compared to the other nutrients.

Table 2 showed significance difference among the khat type ($P<0.05$) in Ca, Zn, Mg, tannin and total phenol contents. In terms of their mineral contents, the Khat types investigated were good sources of calcium, zinc and magnesium. Ca content was highest in Awaday (193.59 mg/100g) and lowest in Galamso (150.94 mg/100g) khat type. The Zn contents of the examined khat types, which ranged from 3.47 mg/100g to 4.03 mg/100g was highest in Galamso (3.98 mg/100g) and Kobo (4.03 mg/100g) khat type while Awaday khat type (3.47mg/100g) had the least. As shown in the table 2, chewing Galamso and Kobo khat type can contributes high amount of zinc. The recommended daily allowance (RDA) level for Zn is 12-15 mg/day [19]. Hence, with other zinc sources of food, chewing about 100g of such khat can satisfy the daily requirement amount of zinc without posing a health risk. The amount of Zn found in this study was higher than the finding reported somewhere else [20] as the Zn contents of Ethiopian Khat ranged between 5.18-9.40 μg/g. Zinc is one of the important trace elements that play a vital role in the physiological and metabolic process of many organisms and at high level.

The highest magnesium concentration (249 mg/100g) was found in Awaday khat type, while the lower amount recorded in Galamso (190.62 mg/100g) khat type. The concentrations of Ca and Mg found in this study were below the finding of Fenta and Kidanemariam [21] who reported that the Ca (2.81-3.14mg/g and Mg 3.9-4.5mg/g). According to Tilahun [22], the

average quantity of khat chewed by Ethiopians is ranging from 100 to 500 g daily. Therefore, chewing 100g of Awaday, Galamso and Kobo Khat type daily can contribute 249.59, 190.62 and 207.66 mg respectively. In the same way chewing 100g of Awaday, Galamso and Kobo Khat type daily can contribute 193.59, 150.94 and 162.82 mg, respectively.

Table 2 Minerals and anti-nutrient contents of Khat

Khat type	Ca mg/100g	Zn mg/100g	Mg mg/100g	Tannin (mg/100g)	Total phenol (mg/100g)
Awaday	193.59±18.36[a]	3.47±0.18[b]	249.00±16.46[a]	126.16±5.85[a]	194.49±17.51[a]
Galamso	150.94±30.06[c]	3.98±0.60[a]	190.62±19.72[c]	114.39±22.92[b]	153.59±10.17[b]
Kobo	162.82±14.37[b]	4.03±0.21[a]	207.66±4.71[b]	111.12±13.21[b]	151.93±28.78[b]
CV (%)	2.54	3.67	1.72	2.18	3.25

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Tannin concentration ranges from 126.16 mg/100g for Awaday khat type as maximum to 111.12 mg/100g and 114.39 mg/100g as minimum for Kobo and Galamso khat type, respectively in statistical parity. The amount of the tannin obtained in the khat type is high and thus it might be the reason why bitter taste is imparted in the khat. Hence, most of the khat chewers use sugar along with khat to overcome the bitter taste of the khat. Tannins are basically polyphenolic compounds having complex mixture and are present in many plants. They form complexes with proteins, starches and digestive enzymes thereby reducing the nutritional value of foods [23] and causing growth depression. It also interferes with protein absorption and reduces iron availability. Tannins also interact with a number of minerals, form precipitates and thus reduce their availability [24]. The minerals which are ionised in the stomach (iron, calcium, magnesium, sodium and potassium) are prone to variety of absorption interferences [25].

Tannins-nutrient interaction may be one of the means by which tannins affect the digestive processes resulting into reduced availability of the nutrients in the gut. Besides exhibiting negative effects tannin also provide some health benefits including antioxidant and radical scavenging properties, anti-carcinogenic, antibacterial and anti-enzymatic effects [26]. The analysis of variance of the results revealed that as total phenol was highest in Awaday khat

type (194.49 mg/100g) while lower in Galamso (153.59 mg/100g) and Kobo (151.93 mg/100g) khat type with no significance difference. The total phenol content of khat is high compared to the vegetables phenol. According to the Ayaz *et al.*, [27], the total phenol of leafy vegetables like kale was recorded as 136 mg/100g which is low by far from the khat. As this study revealed, khat is the good sources of total phenols.

3.2 Sensory Acceptability of Citrus Drinks Supplemented with Khat Powder

The sensory attributes (colour, flavour, aroma, taste and stimulation) of juice produced from Khat, mango, and orange was significantly influenced ($p<0.05$) by khat type and ratio used (Table 3, 4, 5 and 6).

Table 3 Sensory Acceptability score of khat powder and mango juice for khat chewers

Khat type	Attributes					
	Ratio % (mango juice: khat)	Colour	Flavour	Aroma	Taste	Stimulation
Awaday	100:0	6.2 ± 0.63^{abc}	5.9 ± 0.57^{bcd}	5.9 ± 0.57^{abc}	6.1 ± 0.74^{abc}	5.6 ± 0.70^{ab}
	97.5 :2.5	6.5 ± 0.71^{a}	6.5 ± 0.53^{a}	6.4 ± 0.52^{a}	6.4 ± 0.70^{a}	6.3 ± 0.67^{a}
	95:5	6.5 ± 0.71^{a}	6.6 ± 0.52^{a}	6.1 ± 0.74^{abc}	6.2 ± 0.63^{ab}	6.1 ± 0.74^{ab}
	92.5:7.5	6.4 ± 0.52^{ab}	6.4 ± 0.52^{ab}	6.1 ± 0.99^{abc}	6.2 ± 0.63^{ab}	6.2 ± 0.79^{a}
Galamso	100:0	5.7 ± 0.67^{c}	5.9 ± 0.74^{bcd}	6.0 ± 0.82^{abc}	5.7 ± 0.67^{bc}	5.7 ± 0.82^{ab}
	97.5 :2.5	6.2 ± 0.63^{abc}	6.3 ± 0.48^{abc}	6.2 ± 0.42^{abc}	6.1 ± 0.74^{abc}	5.9 ± 0.74^{ab}
	95:5	6.4 ± 0.70^{ab}	6.4 ± 0.52^{ab}	6.2 ± 0.63^{abc}	6.2 ± 0.63^{ab}	5.7 ± 0.67^{ab}
	92.5:7.5	6.1 ± 0.57^{abc}	6.2 ± 0.63^{abc}	6.3 ± 0.67^{ab}	6.2 ± 0.63^{ab}	5.6 ± 1.07^{ab}
Kobo	100:0	6.1 ± 0.74^{abc}	5.8 ± 0.79^{cd}	6.3 ± 0.82^{ab}	5.8 ± 0.79^{abc}	5.7 ± 0.67^{ab}
	97.5 :2.5	6.0 ± 0.82^{abc}	5.9 ± 0.88^{bcd}	6.4 ± 0.84^{a}	5.7 ± 0.48^{bc}	5.6 ± 0.97^{ab}
	95:5	6.0 ± 0.67^{abc}	5.5 ± 0.71^{d}	5.6 ± 0.70^{c}	5.6 ± 0.97^{bc}	5.8 ± 0.92^{ab}
	92.5:7.5	5.8 ± 0.92^{bc}	5.8 ± 0.79^{cd}	5.7 ± 0.48^{bc}	5.5 ± 1.08^{c}	5.4 ± 0.70^{b}
CV (%)		11.32	10.68	11.53	12.40	13.78

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

The highest flavour, aroma, taste and stimulation scores were given for Awaday and Galamso Khat type at most ratios of mango used with no significance difference among them. Whereas, juice of Kobo type Khat perceived as less liked by panellist statistically. The colour of juice produced from Awaday and Kobo Khat types at all ratios were liked statically parity. Though Kobo type of Khat was not statically parity; the score given was falls to the degree of likeness to the same with the other type of khat type at all proportion used which is liked moderately. The results of the study indicated that colour, and stimulation of juice produced from khat and orange was not significantly ($p >0.05$) influenced by khat type and ratio used

(Table 4). The highest flavour, aroma and taste scores were given for Galamso khat type at all ratios of orange juice used with no significance difference.

Table 4 Sensory Acceptability score of khat powder and Orange juice of khat chewers

Khat type	Ratio % (Orange juice: khat)	Attributes				
		Colour	Flavour	Aroma	Taste	Stimulation
Awaday	100:0	5.3±0.52^{a}	5.4±0.52^{d}	5.2±0.42^{c}	5.6±0.70^{bcd}	5.5±0.53^{a}
	97.5 :2.5	5.5±0.53^{a}	5.7b±0.42^{cd}	5.5±0.53^{bc}	5.7±0.67^{abcd}	5.5±0.53^{a}
	95:5	5.9±0.53^{a}	5.8±0.42b^{cd}	5.6±0.70^{bc}	5.9±0.74^{abc}	5.8±0.63^{a}
	92.5:7.5	5.4±0.63^{a}	5.7±0.48^{cd}	5.6±0.84^{bc}	5.5±0.53^{cd}	5.8±0.63^{a}
Galamso	100:0	5.5±0.53^{a}	5.9±0.74^{abcd}	6.0±0.82^{ab}	5.7±0.67^{abcd}	5.7±0.82^{a}
	97.5 :2.5	5.5±0.71^{a}	6.3±0.48^{ab}	6.2±0.42^{a}	6.1±0.74^{ab}	5.4±0.74^{a}
	95:5	5.5±0.85^{a}	6.4±0.52^{a}	6.2±0.63^{a}	6.2±0.63^{a}	5.9±0.67^{a}
	92.5:7.5	5.7±0.53^{a}	6.2±0.63^{abc}	6.3±0.67^{a}	6.2±0.63^{a}	5.6±1.07^{a}
Kobo	100:0	5.7±0.67^{a}	5.5±0.71^{d}	5.6±0.70^{bc}	5.8±0.79^{abcd}	5.7±0.67^{a}
	97.5 :2.5	5.8±0.63^{a}	5.8±0.63^{bcd}	5.8±0.79^{ab}	5.5±0.53^{cd}	5.5±0.85^{a}
	95:5	5.8±0.63^{a}	5.8±0.63^{bcd}	5.6±0.52^{bc}	5.3±0.48^{d}	5.9±0.74^{a}
	92.5:7.5	5.4±0.71^{a}	5.5±0.53^{d}	5.8±0.42^{ab}	5.3±0.67^{d}	5.6±0.70^{a}
CV (%)		11.28	9.73	11.06	11.43	12.85

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

According to the khat chewers panellists, the sensory attributes scores of all khat types at all ratios of mango and orange were between 6.6 and 5.2 indicating that the juices produced were between liked very much to liked slightly.

This may be due to the fact that people had innate (natural) behaviour that they are familiar with the common products and take it as a reference. Furthermore, it may be due to the khat types, and ratios used.

Table 5 Sensory Acceptability score of khat powder and mango juice of non- Khat chewers

		Attributes				
Khat type	Ratio % (mango juice: khat)	Colour	Flavour	Aroma	Taste	Stimulation
Awaday	100:0	6.20±0.63^{bcd}	5.60±0.70^{b}	5.20±0.42^{e}	6.40±0.52^{abc}	5.20±0.42^{c}
	97.5 :2.5	6.80±0.42^{a}	6.60±0.52^{a}	6.50±0.53^{a}	6.70±0.48^{a}	6.30±0.67^{a}
	95:5	6.60±0.52^{a}	6.60±0.52^{a}	6.40±0.84^{a}	6.50±0.53^{ab}	6.00±0.82^{ab}
	92.5:7.5	6.40±0.52^{abc}	6.40±0.52^{a}	6.60±0.52^{a}	6.50±0.53^{ab}	6.00±0.67^{ab}
Galamso	100:0	5.70±0.67^{d}	5.60±0.52^{b}	5.60±0.70^{ed}	5.30±0.48^{e}	5.20±0.42^{c}
	97.5 :2.5	6.20±0.63^{bcd}	6.30±0.48^{a}	6.20±0.42^{abc}	6.60±0.52^{ab}	5.40±0.52^{bc}
	95:5	6.40±0.70^{abc}	6.20±0.63^{a}	6.60±0.52^{a}	6.50±0.53^{ab}	5.30±0.48^{c}
	92.5:7.5	6.30±0.67^{abc}	6.30±0.67^{a}	6.30±0.67^{ab}	5.70±0.67^{de}	5.40±0.97^{bc}
Kobo	100:0	5.70±0.67^{d}	5.30±0.48^{b}	5.30±0.48^{ed}	5.80±0.79^{de}	5.30±0.48^{c}
	97.5 :2.5	6.00±0.82^{cd}	5.50±0.71^{b}	5.60±0.84^{ed}	5.90±0.57^{cd}	5.60±0.97^{cd}
	95:5	6.00±0.67^{cd}	5.60±0.70^{b}	5.80±0.79^{bcd}	6.10±0.88^{bcd}	5.20±0.92^{c}
	92.5:7.5	6.10±0.74^{bcd}	6.60±0.52^{a}	5.70±0.48^{cde}	6.20±0.79^{abcd}	5.60±0.84^{cd}
CV (5%)		10.43	9.70	10.37	10.04	12.84

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Sensory evaluation result of juice produced from khat powder supplemented with mango juice at different proportion showed; parameters like colour, taste, flavour, aroma, and stimulation was significantly influenced ($p<0.05$) by khat type and ratio used (Table 5). The highest colour, flavour, aroma, taste and stimulation scores were given for Awaday and Galamso khat type at most ratios used with no significance difference among them. According to the non-khat chewers panellists, Khat powder supplemented with citrus fruits (mango and orange) at different ratios prepared in this study were between liked slightly to liked very much levels (4.9 to 6.80) using seven point's hedonic scales.

Generally, according to the khat chewers and non khat chewers panellists, the sensory attributes scores of all khat types at all ratios of mango and orange were between 4.9 and 6.8; indicating that the juices produced were between liked slightly to liked very much.

Table 6 Sensory Acceptability score of khat powder and Orange juice of non-khat chewers

		Attributes				
Khat type	Ratio (%) (Orange juice: khat)	Colour	Flavour	Aroma	Taste	Stimulation
Awaday	100:0	5.40±0.70^{bc}	5.60±0.70^{abc}	5.80±0.92^{a}	5.40±0.70^{cde}	5.10±0.57^{bc}
	97.5 :2.5	6.30±0.67^{a}	6.10±0.99^{ab}	5.30±1.16^{a}	6.10±1.20^{abc}	5.70±0.67^{ab}
	95:5	6.20±0.79^{a}	5.60±1.07^{abc}	5.80±0.92^{a}	6.50±0.53^{a}	5.40±0.52^{abc}
	92.5:7.5	5.50±0.71^{bc}	5.80±1.03^{abc}	5.60±1.07^{a}	5.60±0.84^{bcde}	5.00±0.82^{c}
Galamso	100:0	5.20±0.79^{c}	5.10±0.74^{c}	5.10±0.74^{a}	5.30±0.48^{de}	4.90±0.57^{c}
	97.5 :2.5	5.30±0.82^{bc}	5.40±0.84^{bc}	5.30±0.95^{a}	5.90±0.88^{abcd}	5.80±0.79^{a}
	95:5	5.40±0.70^{bc}	5.60±0.97^{abc}	5.40±0.97^{a}	5.70±0.67^{bcde}	5.30±0.48^{abc}
	92.5:7.5	5.00±0.94^{c}	5.70±0.67^{abc}	5.50±0.85^{a}	5.00±0.82^{e}	5.40±0.97^{abc}
Kobo	100:0	4.90±0.88^{c}	5.70±0.82^{abc}	5.30±0.48^{a}	5.20±0.79^{de}	5.30±0.48^{abc}
	97.5 :2.5	5.30±0.67^{bc}	5.20±0.63^{c}	5.60±0.84^{a}	5.50±0.97^{bcde}	5.20±0.79^{abc}
	95:5	5.20±0.79^{c}	5.30±0.67^{c}	5.20±0.79^{a}	5.50±0.85^{bcde}	5.20±0.92^{abc}
	92.5:7.5	5.90±0.74^{ab}	6.20±0.79^{a}	5.70±0.48^{a}	6.20±0.79^{ab}	5.80±0.92^{a}
CV (5%)		14.10	15.01	15.92	14.38	13.64

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

From the output of the sensory evaluation, what to be observed is as khat can be consumed in different food forms like juice apart of chewing as fresh. Farmers in eastern Ethiopia often start chewing *khat* right after breakfast and work for about 3 hours without any feeling of fatigue. After lunch, they resume chewing and work through the remaining afternoon with intermittent chewing. It is evident that *khat* chewing competes for active working time in that the actual working hours do not exceed 6-8 hours a day [28].

Furthermore, in areas where *khat* chewing is common, punctuality of business appointments is a frequent problem, as the time after lunch is usually spent in chewing *Khat.* As with most other addictions, when a regular *khat* chewer is not getting *khat* he/she feels uncomfortable, becomes restless and aggressive. During this period one cannot be expected to behave well or to respond positively to any query. In Ethiopia, *khat* consumers include sexes (at varying level), farmers, traders, teachers, students, health and military people, drivers, government officials and foreigners. Therefore, such alternative product can use to save the time of the chewers, increase the shelf life and reduce the wastage of the khat, may help in health problems related to chewing khat and generate incomes.

3.3 Conclusions

Khat is an important cash crop in Ethiopia particularly both in east and west Hararghe and well-known for its foreign currency earnings. In this study, commercially available Khat from Awaday, Galamso and Kobo were analysed for their nutritional and anti-nutrient contents. Moreover, juice was prepared from citrus fruits (mango and orange) separately and blended with khat powder in ratios of (100%:0%, 97.5%:2.5%, 95%:5%, 92.5%:7.5% respectively. The produced juices were then ready for sensory evaluation. The results revealed that significant differences were observed in nutritional and anti-nutrient content among khat types. The highest total ash was obtained for Galamso (6.19%) and Kobo (6.5%) khat types in statistical parity. Awaday type of khat had high percentage of protein (14.41%), but Galamso and Kobo had lower values of 12.54% and 12.68% values of protein, respectively. Ca content was highest in Awaday (193.59 mg/100g) but lowest in Galamso (150.94 mg/100g) khat types. The Zn contents were ranged from 3.47 mg/100g to 4.03 mg/100g and it was highest in Galamso (3.98 mg/100g) and Kobo (4.03 mg/100g) khat types. Tannin concentration ranged from 126.16 mg/100g for Awaday khat type as maximum to 111.12 mg/100g and 114.39 mg/100g as minimum for Kobo and Galamso khat types. According to the khat chewers and non khat chewers panellists, the sensory attributes scores of all khat types at all ratios of mango and orange were between 4.9 and 6.8; indicating that the juices produced were between liked slightly to liked very much on seven hedonic scale.

It could, thus, be concluded that all types of khat (Awaday, Galamso and Kobo) though had different nutritional contents; all were good sources of nutrients. Furthermore, the score given by panellist for sensory attributes revealed that the acceptances of the juice drinks produced by supplementing Khat powder were high.

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