Process Development, Nutrient and Sensory Qualities of Hot and Sweet Sauce with Tamarind (*Tamarindus Indica* L.)

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Abstract

Tamarind is a nutritious and drought resistant wild fruit that is underutilized in many countries of the world including Kenya. As one way of its utilization, a study was conducted to develop hot and sweet sauce, popular among many Kenyan communities using tamarind, determine its physic-chemical characteristics and evaluate its sensory acceptability among consumers. Three variations of hot and sweet sauce with none, 30% and 60% tamarind, respectively were formulated and developed. To establish the physico-chemical characteristics, proximate composition, acidity and viscosity were determined. Acceptability was evaluated using hedonic categorization on a 9-point scale and preference ranking by 50 University of Eldoret students who normally use chili. Compared to the sauce without tamarind, nutrient content increased in 60% addition of tamarind, by 39% protein, 17% ash and 6% fat. Viscosity also increased by 40%, while moisture and pH reduced by 65% and 28%, respectively. Sensory evaluation results showed that the sauce with 60% tamarind was rated highest for the attributes of texture, flavour, sweetness, hotness and overall acceptability. Additionally it scored highest on total quality (93%) and was the most preferred of the three variations by consumers. Addition of tamarind to hot and sweet sauce improves its nutrient content, physical characteristics and sensory properties. Further research should be conducted into incorporating tamarind into more Kenyan food products to improve nutrition and boost food security. Simple techniques to process mature tamarind pod for pulp to enhance its industrial use should be developed.

Key Words: Tamarind, Sauce, Consumer Acceptability, Nutrient Content, Value Addition

Introduction

Fruits from trees offer seasonal, supplemental and emergency contributions to household food supplies globally (Tengnas, 1994). Several indigenous tropical wild fruit tree species are underexploited and not conserved as most are not grown by farmers (Mbora, Jamnadass, & Lillesø, 2008), yet the fruits have high nutritional value and unique tastes. Such useful trees need to be identified for utilization in food, beverage and other industrial products (Singh, Wanchu, & Moond, 2007).

Tamarindus (*Tamrindus indica L*) is an indigenous tree species of tropical Africa, where it is widely used by the local people, who commonly eat the fruit pulp raw (El Siddig *et al.,* 2006). Production on a commercial scale is limited. However, it has been introduced and naturalized in over 50 countries worldwide that produce a wide range of commercial products. Tamarind is used as a source of food, food preservative, fodder, firewood and timber (Ewédjè, & Tandjiékpon, 2011). Additionally, it has medicinal value with antioxidant, antimicrobial, hypolipidimic, antidiabetic and digestive properties (Isha, & Milind, 2012) among others. All parts of Tamarind plant including the roots, leaves and wood are utilized, but the most valuable part is the fruit and pulp.

Tamarind fruit which contains about 30-50% of edible pulp (Pursglove, 1987) is simultaneously a very acidic and yet sweet fruit, attributed to the high tartaric acid content and reducing sugars, respectively (El-Siddig *et al.,* 2006). The pulp also contains high levels of, carbohydrate, protein, calcium, phosphorus, fibre, iron, vitamin B_2 and some vitamin C (Singh *et al.,* 2007). The fruit is consumed raw or used in juice, jam, syrup, candy, curries, salads, seasonings, and for preparing sauces.

In Kenya, tamarind is found in the semi arid areas and wooded grasslands of the Coast, Southern, North Eastern and Nyanza provinces (Mbora *et al.,* 2008). The plant and fruit are popularly called *Mkwaju* and *Hamar* in the Swahili and Somali languages, respectively (ICRAF, 1992). In spite of its availability in parts of the country, the tamarind tree remains unimproved and the fruit underutilized to meet growing commercial demand. Therefore, tamarind product development and diversification is required for commercial exploitation in Kenya and other African countries.

The Somali and Asian communities of Kenya prepare a cultural chilli sauce incorporating tamarind, which gives it a unique hot and sweet taste, on a domestic basis. However, the ingredients and procedure vary among households. Developing a standard procedure for the production of the hot and sweet sauce would add value to tamarind and give the product the potential for commercialization. There is no published literature of an empirical study on a developed hot and sweet sauce using Kenyan tamarind. Therefore, the aim of the study was to develop hot and sweet sauce with tamarind and evaluate the physical, nutritional and sensory characteristics.

Materials and Methods

Materials

Mature tamarind (*Tamarindus Indicus* L.) fruit, fresh tomatoes, chili, onion, garlic and coriander were obtained locally from the market in Eldoret, Kenya. Commercial stabilizer (carboxymethyl cellulose) and preservative (sodium benzoate) both from Pradip East Africa, Nairobi, Kenya as well as vinegar and citric acid were also purchased in Eldoret.

Processing Tamarind Sauce

All the raw ingredients were selected sorted and washed. A kg of tamarind fruit was steeped in 300 ml of boiling water, allowed to soak for 1 hour and the pulp separated from the seed by mixing and rubbing. The paste obtained was sieved to remove seed and other extraneous material. Tomato puree with chili was prepared using 1 kg of blanched and skinned tomatoes, which were cut to medium size, mixed with fresh diced chili (50 gm), onion (100 g), coriander (10 g), and garlic (10 g) then blended using a laboratory blender at medium speed for 2 minutes. Three variations of hot and sweet sauce were formulated using tamarind paste and tomato puree with 0, 30% and 60% replacement of tomato puree with tamarind paste. The sauces were heated to boiling, vinegar (5 g) and citric acid (5 g) added and then simmered for 30 minutes. The stabilizer (5 g) was added midway during the heating process and the preservative (5 gm) at the end. The sauces were cooled and packaged in polyethylene bottles. Figure 1 shows the flow chart for processing hot and sweet sauce.

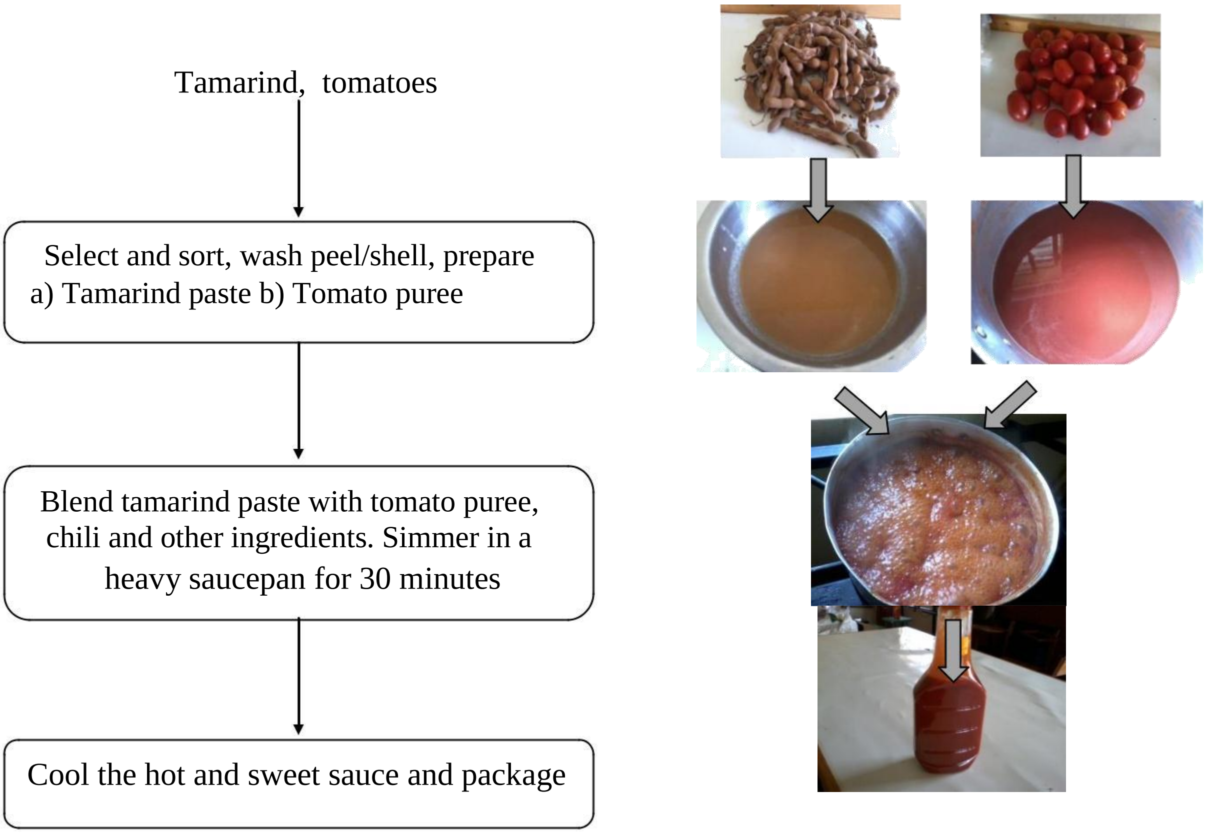


Figure 1. Flow Chart for the Preparation of the Hot and Sweet Sauce with Tamarind

Physicochemical Analyses

The total solids of the samples were determined according to AOAC International (1990) method 967.03 with some modifications. The three samples were dried in an oven for 20 hours. Protein content (N x 6.25) was determined by the Kjehdahl method 920.87 AOAC International (1995). Ash (minerals) and fat and were determined by dry ashing and soxhlet methods 30-25 and 08-01, respectively AACC International (2000). Carbohydrate content was calculated by difference after accounting for moisture, protein, fat and ash while energy was calculated using Atwater conversion factors (FAO, 2003). The pH was determined using a portable digital pH meter (Model HI 1270 Checker®, Hannah Instruments, Rhode Island, USA). Viscosity for the three samples was compared using the linespread test (McWilliams, 1989) whose results have been found to correlate well with a viscometer (Grawemweyer & Pfund, 2006; Budke, Garcia, & Chambers, 2008)

Evaluation of Consumer Acceptability

Sensory evaluation was conducted in the food preparation laboratory of the University of Eldoret. Consumers (50) comprising 23 males and 27 females aged 20-35 years who were students of the university were invited to evaluate the three samples. Consumer screening was done to select individuals who usually use pepper in their diet and had no allergies. Each panelist signed a consent form informing him/her of the nature of the samples they would evaluate before engaging in the sensory exercise. Evaluation was carried out on one day in two sessions of 1 hour each following a randomized complete block design. A nine-point hedonic scale (dislike extremely – 1: neither like nor dislike – 5 and like extremely – 9) was used to determine consumer liking of colour, flavour, texture, hotness, sweetness and overall acceptability for each sample (Peryam, & Pilgrim 1957). All three samples were randomly presented to each consumer, with each sample of 5 ml presented on a white disposable plate labeled with randomized three digit codes. Bottled water and carrot slices were provided to cleanse the palate. Responses for the evaluation were entered into a score sheet.

Preference testing was also conducted and consumers were asked to rank the three variations of sauce from the most preferred to the least preferred (Lawless, & Heymann, 2010).

Statistical Analyses

All analyses except the consumer evaluation were done in triplicate. Data were analyzed using one way analysis of variance (ANOVA) and means were compared using Fisher‘s least significant difference (LSD) test. Statistica software version 8.0 (Statsoft, Tulsa, OK) was used. Consumer hedonic score distribution was illustrated using box and whisker plots.

Results and Discussions

Physicochemical Properties

The results for the physicochemical properties of the three variations of hot and sweet sauce with 0, 30% and 60% tamarind are shown in table 1. Increasing the percentage of tamarind in hot and sweet sauce increased acidity by 13.8% at 30% and 27% at 60% addition. This may be explained by the significantly high amounts of organic acids found in tamarind constituting 98% tartaric acid as well as acetic, citric, formic, mallic and succinic acids (Singh *et al.,* 2007). Adeola & Aworh (2010) also reported increased acidity in a beverage made from Nigerian tamarind. Tamarind has been used as an acidulant in food preparation in India and other Asian countries (Gunasena, & Hughes, 2000). Acidity in food processing is important because it inhibits growth of heat resistant microorganisms and increases the efficiency of thermal processing (Schoenemann, Lopez, & Cooler, 1974) and shelf stability.

The sauce with 60% tamarind reduced spread by 40% compared to the 100% tomato puree sauce, implying increased viscosity. Similar results were reported by Ahmed *et al.,* (2007) who, detected viscoelastic properties in tamarind juice concentrate ranging at shear rate 33.5 and 36 kj /mol. This may be attributed to pectin, found in tamarind fruit pulp and is the main ingredient responsible for gelling in jams and jellies. In a study by Sulieman *et al.,* (2010), pectin extracted from tamarind pulp was used to make acceptable pumpkin jam. Tamarind seed also contains xyloglucan a polysaccharide with gelling properties and is a commercial additive for improving viscosity and texture of processed foods (Sone, & Sato, 1994).

The protein, fat and ash values in 60% tamarind added sauces increased by 39%, 67% and 16%, respectively compared to the 100% tomato puree sauce. Studies have shown that the content of these nutrients in tamarind pulp are higher than the 1.1, 0.02 and 1.5 g/100 g protein, fat and ash, respectively in the 100% tomato puree sauce. For example, the ranges for protein fat and ash were 3.1-5.4, 0.1-1.99 and 2.4-2.9 percent (Morton, 1987; Sulieman *et al.,* 2010). Therefore, addition of fruit pulp increased the quantities of these nutrients in the sauces. Tamarind pulp contains substantial amounts of phosphorus, calcium, iron, sodium and potassium (Singh *et al.,* 2007), which account for the increased ash content. In contrast, there was significant (65%) reduction of moisture in the 60% tamarind sauce attributed to the lower (18%) content in tamarind pulp (Morton, 1987) and evaporation during thermal processing. The findings in this study support the postulation in a review by De Caluwé, Halamová, & Van Damme (2010) that tamarind has low water content and high protein, carbohydrate and minerals.

Table 1. Physicochemical Properties of Hot and Sweet Sauce with Tamarind

Sauce type	pH	Viscosity	Moisture	Protein	Fat	Ash	Energy[1] Kcal g/100g
TPu100	$3.6^{c}\pm0.01$	$0.5^{b}\pm0.06$	$44.8^{c}\pm0.76$	$1.1^{a}\pm0.01$	$0.02^{a}\pm0.01$	$1.5^{a}\pm0.01$	15.57
TPu70:TPa30	$3.1^{b}\pm0.01$	$0.4^{ab}\pm0.06$	$32.0^{b}\pm0.50$	$1.2^{b}\pm0.01$	$0.04^{b}\pm0.01$	$1.7^{b}\pm0.01$	15.94
TPu40:TPa60	$2.6^{a}\pm0.01$	$0.3^{a}\pm0.06$	$15.7^{a}\pm0.76$	$1.8^{c}\pm0.01$	$0.06^{c}\pm0.01$	$1.8^{c}\pm0.01$	16.98

Values are means ± standard deviation. Values in a column followed by different letter superscripts are significantly different at $P \leq 0.05$ as assessed by Fisher's least significant difference.

[1]Calculated using the following factors: carbohydrates yield (4.0 kcal), fat (9.0 kcal), and protein (4.0 kcal)

TPu – Tomato Puree; TPa – Tamarind Paste

Sensory Evaluation

Table 2 shows that consumers liked the colour of the 100% tomato sauce 6% to 8% more than the sauces with tamarind. A possible explanation is that the tamarind sauce had a darker colour than the sauce without tamarind. A previous study by Sulieman *et al.* (2010) demonstrated that a darker pumpkin jam with tamarind pectin was rated lower than the lighter one with commercial pectin. Adeola and Aworh (2010) also noted that a tamarind drink that was darker scored lower than a lighter one. The darkening may have resulted from Maillard browning when the amino acids and reducing sugars in the tamarind were subjected to thermal processing (Alais & Linden, 1991). Additionally, prolonged heating may have caused β- carotene and lycopene in the tamarind pulp to decompose, further darkening the colour.

The flavour of the sauces with tamarind had higher (2-8%) hedonic scores than the sauce without. It is likely that the tamarind introduced a unique flavour to the sauce. Other researchers have also shown that the flavour of food products developed with tamarind is liked by consumers (Jyothirmai, Rao, & Rao, 2006; Jittanit, Chantara-In, Deying, & Ratanavong, 2011). Some compounds that influence tamarind flavour include pyrazines, thiazoles, furans and some carboxylic acid derivatives such as palmitic, oleic and phenylacetaldehyde (Wong, Tan, Chow, & Chee, 1998).

The liking for sweetness of sauces with tamarind by the consumer panel was also significantly higher (16%) than the 100% tomato sauce. It is likely that the high percentage (30 to 41%) of invert sugar in the fruit pulp (Morton, 1987) is responsible for the higher perception of sweetness. Consumers‘ liking for the hot taste of the tamarind sauce was higher by 8% compared to the sauce without tamarind. This suggests that the hotness was more tolerable to consumers. It is possible that the sweet and tart taste notes from sugar and acid, roasted flavour from pyrazines (Bredie, Mottram, Hassell, & Guy, 1998) and other aromatic compounds in tamarind toned down the usual sharp chili taste in hot and sweet sauce, making the sauces more acceptable to consumers. Consequently, the consumer rating for overall acceptability of the hot and sweet sauce with tamarind was 10% higher.

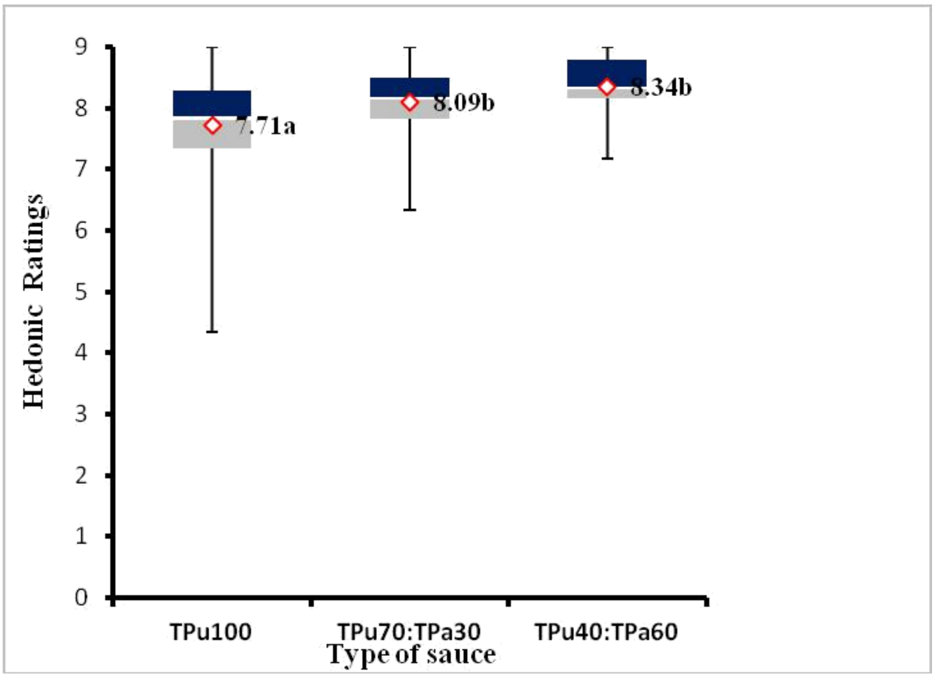
Table 2. Consumer (N=50) Perception of Sensory Attributes for Hot and Sweet Sauce with Tamarind

Sauce type	Colour	Texture	Flavour	Hotness	Sweetness	Overall acceptability
TPu100	$8.58^{b}\pm0.75$	$7.70^{a}\pm0.93$	$7.64^{a}\pm1.33$	7.54^{a} 1.32	7.26^{a} 1.32	7.60^{a} 0.90
TPu70:TPa30	$7.86^{a}\pm0.83$	$8.06^{a}\pm0.99$	$8.32^{b}\pm0.91$	8.00^{b} 0.90	8.14^{b} 0.94	8.16^{b} 0.73
TPu40:TPa60	$8.06^{a}\pm0.65$	$8.04^{a}\pm0.92$	$8.16^{b}\pm1.09$	8.28^{b} 0.78	8.66^{c} 0.65	8.46^{b} 0.70

Values are means ± standard deviation. Values in a column followed by different letter superscripts are significantly different at $P\leq 0.05$ as assessed by Fisher‘s least significant difference.

TPu – Tomato Puree; TPa – Tamarind Paste

Rating for total score for liking of the three variations of sauces in figure 2 showed that there was no significant difference between the liking for the 30 and 60% tamarind sauces, but there was a higher (5-8%) liking for the two sauces with tamarind compared to the one without. These findings contrast with those reported by Sulieman *et al.* (2010) for jam with tamarind which was equally liked with jam without. Figure 2 also shows that there was a short distribution of scores along the bar line of the graph indicating agreement among the consumer panelists over the total quality of the three variations of sauces. Additionally, it shows there was consistency when hedonic categorization was used as a tool of assessment.



Means are significantly different at P≤0.05. TPu – Tomato Puree; TPa – Tamarind Paste. The dark shaded area is the higher percentile and represents the value above which 75% of the ratings fell. The light shaded area is the lower percentile and represents the area where 25% of the ratings fell. The median is the border between the two shaded areas. Hedonic scale rating, Dislike extremely =1: Neither like nor dislike = 5 and Like extremely = 9.

Figure 2. The Effect of Addition of Tamarind to Hot and Sweet Sauce on Total Quality Ratings by Consumers (N=50)

Although, there was no significant difference between the sauces with tamarind using hedonic categorization, consumers ranked the 60% tamarind sauce first and the plain one last. All the consumers also agreed that if the tamarind sauces were availed on the market, they would purchase them for consumption. This may best be explained by the improved flavour and nutrients due to addition of tamarind.

Conclusion

The addition of tamarind increases the product‘s nutritional content in terms of protein, fat, ash (minerals), carbohydrate and energy. The sensory properties of flavour, sweetness, hotness and total quality of the product improve. The hot and sweet sauce with tamarind has potential for acceptance by consumers as a commercial product. Further research should be conducted into incorporating tamarind into more Kenyan food products to improve nutrition and boost food security. Simple techniques to process mature tamarind pod for pulp to enhance its industrial use should be developed.

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