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QUALITY CHANGES AND SHELF LIFE STUDIES OF TAMARIND CHEESE

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ABSTRACT: Studies were conducted to determine optimum setting conditions and storage temperature of tamarind cheese. Optimum setting conditions were identified at pH 2.5-2.8, with corn syrup, with or without preservatives at 70^0Brix and an end point temperature of 105^0C. Treatments with corn syrup were identified as more acidic than treatments without corn syrup but the texture of the latter was firmer than the former. Treatments stored at 30^0C decreased in firmness, with the opposite effect taking place at 10^0C. No microbial growth was observed throughout the 28 day storage period.

INTRODUCTION

Tamarind (*Tamarindus indica*) is a member of the leguminosae family (Nagy and Shaw, 1980; Shankaracharya 1998). It is considered as a minor fruit crop, native to Tropical Africa and cultivated in the Tropics and Subtropics (Shankaracharya, 1998; Morton, 1987; http://www.safari.net/~lychee/tamarind.htm). Among the many names for the fruit, the most common ones are: Tamarin, Tamarindies, Tamarindo and Imli (Morton, 1987).

Currently, the utilization of tamarind pulp is limited to the production of tamarind balls, tamarind sauce and tamarind juice. Less than 100 tonnes of tamarind is utilized in Trinidad and Tobago as opposed to 500 tonnes of citrus and 300 tonnes pineapple and guavas (Francis, 1995). These statistics emphasize the need to diversify the utilization of the tamarind fruit into other value added products.

Fruit cheese is a jam like product, with or without spices, and is served as an appetizer or a dessert (Jethro 1988). A major drawback in the production of fruit cheeses is determining the correct matrix with respect to temperature, pectin content, soluble solids content and pH (Kratz, 1993; Lashley, 1994; Marshall, 1986; Vandergarde et al., 1994). Manipulation of these factors optimize setting conditions for fruit cheeses.

While the tamarind pulp has been utilized in the production of jams, jellies, sherberts, drinks and fruit powders, there is no published information on the production of fruit cheese.

The objective of this investigation is to determine the effect of end point temperature, pH, concentration of pectin and percent soluble solids to optimize the setting point and shelf life of tamarind cheese.

MATERIALS AND METHODS

Ninety (90) kg of tamarind fruit (*Tamarindus indica)* was obtained locally in North Trinidad. The fruits were washed and shelled manually, by breaking the shell from the pulp and removing the fibers from the fruit. The tamarind was boiled in a 2:1 ratio of water to tamarind for 20 minutes and left at ambient temperature (30^0C), followed by agitation and pulping using a 2×2 mm wire- mesh sieve. The tamarind pulp was then stored in polyethylene bags at -18^0C and used for further investigations.

Pectin was mixed with 80g sugar and slowly added to 320 ml distilled water while blending on speed 2 of a Waring commercial blender, model 34BL97 (7012). The preservative potassium sorbate (0.1%) was mixed with the sugar and pectin. The quantity of pectin added to the solution varied depending on the percentage of the pectin solution required. Soluble solids of the pectin solution were standardized to 20^0 Brix by the addition of water or sugar if the percent soluble solids was too high or low.

Tamarind cheese was prepared by adding 160g sugar, 80 ml fructose corn syrup (55 HFS) and 5 ml soya oil to 500 g tamarind puree (15^0 Brix) and concentrated to 75^0 Brix (Figure 1). Pectin solution was rapidly incorporated into the mixture and allowed to set in a stainless steel tray over water at 10^0 C. The cheese was then cut into cubes 3 cm^3 and dusted in corn flour.

The pH, soluble solids, % pectin and type of pectin were varied to determine the optimum setting point of the tamarind cheese. Tamarind cheese was divided into four groups, with four replications in each group. Group A: 2.0 pH; Group B: 2.5 pH; Group C: 3.0 pH; Group D 3.5 pH. Trials for each group were conducted at concentrations of 1,2,3 and 4% pectin solution (Medium rapid set pectin 8611 and Low- methoxyl pectin) and 50, 60, 70, and 80% soluble solids. Each trial was repeated replacing 20% sucrose with fructose corn syrup (55 HFS). pH lower than 2.0 was obtained by the addition of potassium citrate prior to the addition of sucrose.

The experiment consisted of the following 8 treatments: 2.5 pH with corn syrup and preservative; 2.5 pH with corn syrup with out preservative; 2.5pH without corn syrup with preservative; 2.5 pH without corn syrup without preservative; 3.0 pH with corn syrup and preservative; 3.0 pH with corn syrup with out preservative; 3.0 pH without corn syrup with preservative; 3.0 pH without corn syrup without preservative

The samples were stored in plastic containers at 10^0C and at ambient temperature (30^0C) for 28 days. The samples were analyised for colour, texture, pH, organoleptic quality attributes, bacteria, yeast and molds on the initial day of processing and on a weekly basis thereafter, until the 28^{th} day of processing. Sensory data was provided for the initial and the 28^{th} day since no difference was reported on the other days between this period.

Colorimetric values L, a, b were recorded for each sample using a Minolta Colorimeter CR 200b model 75043073 and texture analyised using a Koehler texture analyzer model K 19550. Total soluble solids was measured using a Cole Parmer Ins. Co. hand held refractometer of $58\text{-}90^0$ Brix FA 2000 model 02940-25. A standard volume of cheese (10 ml) was diluted with distilled water (30 ml) and used for measurement of pH and titratable acidity (TA) against 0.1N NaOH to an end point of pH 8.1 using an Orion pH meter 520A with a glass electrode.

Microbiological procedures were used to analyse the samples for general microbial growth in plate count agar and yeast/ molds in potato dextrose agar by the pour plate method. Four replicates of each sample was produced and sterile water blanks were used as a quality control measure. All samples were analysed for reducing sugars and total sugars (Miller, 1959).

Sensory evaluation was conducted on a 50-member panel that consisted of males and females from the age of 8 years and above. Each panelist received a single sample of the cheese sequentially for evaluation. The pieces of cheese were coded for identification and the order of presentation was counterbalanced across the subjects to avoid bias. The panelists were required to evaluate the samples for preference to the following end point descriptors: texture, colour, flavour and overall acceptability. The panelists were also required to rank the samples in order of acidity, with 1 dislike extremely to 9 like extremely. A triangle test was conducted to determine if a sensory difference could be detected in the samples with preservative and without preservative and in samples with corn syrup and without corn syrup.

Statistical analysis was performed using MINITAB software, version 12.12. The General Linear Model (GLM) procedure was employed. All significant differences were reported at the 95% confidence level. The experimental design was completely randomized and all groups and measurements were performed in quadruplicate.

RESULTS AND DISCUSSION

Optimum texture and flavour of tamarind cheese were achieved at pH 2.5 with corn syrup. Similar results were achieved in treatments with corn syrup, but without preservative. Increased firmness in treatments was more acceptable by the taste panelist with the exception of treatments at pH 2.5 with and without corn syrup (Table 1). A significant difference was observed in the taste of samples with corn syrup and the samples without corn syrup. Firmer textures were preferred, as softer textures had an inferior mouthfeel and were disliked by adolescence and adults (Mac Fie and Meiselman, 1996).

Treatments at pH 2.5 with corn syrup were less firm but more preferable than treatments at pH 2.5 without corn syrup (Table 1). The Wundt curve, relating sensory intensity to hedonic responses, could be used to explain these textural preferences (Mac Fie and Meiselman, 1996). This curve implies that the sensory intensity of a given stimulus increases to a maximum level then becomes unpleasant at the highest sensory intensity (Mac Fie and Meiselman, 1996). Treatments at pH 2.5 with corn syrup could be described as the maximum level, which decreases in acceptability as the product increases in firmness indicating that texture is a critical factor in the determination of the hedonic tone.

An r^2 value of 0.50 indicated a correlation between pH and texture. This correlation is mainly due to hydrogen bonding and the optimum pH necessary to optimize this bonding. When water was added to the fruit pulp, the negative charges associated with the pectin molecules repelled each other and prevented the hydrogen bonding necessary for gel formation (Marshall, 1986; Vangarde et al., 1994). As indicated previously, gels are formed when polymer molecules interact over a portion of their length to form a network that entraps solvent and solute molecules, resulting in the formation of junction zones (Vangarde et al., 1994). The presence of acid neutralized the negative charges resulting in hydrogen bonding and the formation of junction zones, hence, treatments at pH 2.5, resulted in the firmest gel (Figure 2).

Too much acid caused excessive bonding of pectin molecules due to decreased repulsion. This bonding apparently squeezed out the water that should be held in the spaces between the molecules, resulting in synersis and the formation of a weak gel, hence the gel formed in treatments at pH 2.0 were weak (Figure 2).

Treatments at pH 2.5 were firm in texture due to the greater number of non- ionized carboxyl groups, which enhanced the non- covalent attraction among the methoxyl, alchol and carboxyl groups. At higher pH values, repulsion was increased and hydrogen bonding decreased, resulting in a weaker set, which was observed in treatments at pH 3.0 and 4.0.

Although, the texture of treatments at pH 2.5 without corn syrup, was preferred to pH 2.5 with corn syrup, the flavour of the latter was more acceptable. This may be attributed to the increased acidity of the samples with corn syrup, as the flavour of the more acid samples were generally preferred.

The sweetness of fructose was perceived on the tongue by panelists more quickly than sucrose, due to the greater diffusion rate and the lower viscosity of fructose (Schenck and Aebeda 1992). This perceived sweetness of fructose reaches a peak and dissipates more quickly than sucrose, allowing the acid flavour to be perceived more clearly, hence, treatments with corn syrup were perceived as more acidic than treatments without corn syrup.

Fructose has a unique sweetness response compared to other sweeteners and is reported to improve the flavour of products. Due to its early detection and dissipation, fructose enhances flavours that develop later in the response cycle and is compatible with fruit and spice flavours (Schenck and Aebeda, 1992).

A set of stimuli and mechanisms of molecular interaction with the taste receptor cell has been proposed for each taste. The sour taste has been known to be proton- donating molecules, thus, sourness of foods are directly attributable to the presence of hydrogen ions (Schenck and Aebeda, 1992).

Acidity is a critical factor in the acceptance of tamarind cheese, and is correlated with texture. In preliminary investigations, treatments at pH 2.0, were softer than pH 3.0 and as previously indicated, treatments with a softer texture, were generally disliked.

Preference for treatments at pH 2.5 may have been influenced by increased firmness of treatments at this pH. Individuals generally have an innate preference for sweet, however, as described by the Wundt curve, the preference for sweetness decreases as it passes the maximum threshold (Mac Fie and Meiselman, 1996). Acidity suppresses the perceived sweetness of foods and beverages, shifting its acceptance higher or lower, therefore, an optimum balance of sour and sweet may have been obtained at pH 2.5.

The texture of tamarind cheese also influenced brix, end point temperature and to a lesser degree, % pectin solution. As the water leaves its binding sites on the pectin molecules and binds to the co solute, the pectin molecules are left with free sites, which can participate in pectin- pectin bonding. This greater contact between the pectin chains, results in the formation of junction zones and a network of polymer chains that entraps water and solute molecules (Marshall, 1986 and Vangarde et al., 1994).

Treatment at 50% soluble solids resulted in a soft set (Figure 3), due to the low concentration of soluble solids, which was insufficient to dehydrate the pectin molecules (Figure 3). Treatments greater than 70% soluble solids resulted in the increased size, increased dehydration and number of junction zones, which resulted in precipitate formation.

Concentrations of 1% pectin solution resulted in a softer set than 2 and 3% pectin solution, due to the decreased concentration of pectinic acid and number of junction zones. The inverse reaction resulted in a firmer texture of trials at 3% pectin solution. The number of junction zones was increased by the utilization of 3% pectin, resulting in a product of firm texture. For this reason, 3% pectin solution was identified as the optimum treatment (Figure 4).

Treatments at 4% pectin solution resulted in a soft set. This was due to an increase in the concentration of hydrated pectinic acid and insufficient concentrations of co solutes to dehydrate the pectinic acids.

The soluble properties of pectin must also be considered. Pectins are insoluble in aqueous solutions, however, they are soluble in pure water, hence, pectin was added as a solution not a solid. Dissolved pectins undergo deesterification and depolymerization in aqueous systems at rates below and above pH 4.0 (Marshall, 1986).

The texture of tamarind cheese was not only influenced by processing, but by storage as well. There was an increase in the firmness of treatments at 10^{0}C due to water loss from evaporation (Table 2). This may be due to temperature fluctuations in the environment, causing the relative humidity in the package to be higher than that of the environment (Earle 1983 and Stringer 1992). In order to achieve an equilibrium relative humidity, the product would loose moisture to the environment, resulting in a product with a firmer texture.

An optimum temperature of 105^{0}C was identified, as this resulted in a firm gel (Figure 5). Temperatures of 110^{0}C and 115^{0}C resulted in the formation of a weak gel due to the formation of invert sugar. During this inversion, sucrose (1 molecule) becomes invert sugar (2 molecules), resulting in an increase in the boiling point, however, the dehydration effect on pectin does not double, causing insufficient water to be evaporated (Marshall, 1986). An end point temperature of 105^{0}C resulted in sufficient evaporation of water and the formation of a firm gel.

Condensation was observed in samples at 10^{0}C. At 10^{0}C, the temperature on the inside of the container was higher than the external temperature. During refrigerated storage, cold air circulated over the product, resulting in the removal of heat. On cooling, heat formed inside the package, was transferred to the external environment causing the hot air to condense on the surface of the package at its dew point (Earle, 1983 and Stringer, 1992). Large headspaces resulted in more hot air circulation, resulting in a greater amount of heat transfer and condensation which could increase the probability of microbial spoilage and shorten the shelf life of the product.

The hygroscopic nature of fructose facilitated greater water absorption as the humidity increased (Schenck and Hebeda, 1992). This absorption of water in the product resulted in a softer texture, hence, treatments with corn syrup was softer than treatments without corn syrup throughout the storage period.
Sucrose is also hydroscopic, but to a lesser extent than fructose, therefore treatments with corn syrup were softer than those with out corn syrup throughout storage at 30^{0}C.

No microorganisms were observed at pH 2.5 and pH 3.0. Most bacterial organisms cannot grow at pH values of 2.5 and 3.0, although these are favorable conditions for the growth of yeasts and molds even with the addition of preservatives.

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Wash, shell and sort tamarind

↓

Boil in a 2:1 water to tamarind ratio for 20 minutes, cool, agitate and pulp

↓

Decrease pH to 2.5-3.0 by the addition of potassium citrate

↓

Add sugar, corn syrup (optional) and oil to tamarind pulp and concentrate to 75 % total soluble solids

↓

Pectin solution→ Add pectin solution

Mix sugar and pectin

↓

Allow to set in heat proof dish over water 10^0 C

Slowly add to water while blending on a low speed

Standardize to 20% total soluble solids

Figure 1. Flow chart of the production of tamarind cheese

Table 1. Effect of pH on sensory quality attributes of Tamarind cheese after 1 and 28 days of storage at 30°C.

Treatments	Texture[W]		Flavour[X]		Overall acceptance[Y]		Acidity[Z]	
	1 day	28 days	1 day	28 days	1 day	28 days	1 day	28 days
Samples with corn syrup								
2.5 pH + preservative	7.8 [a]	6.8 [a]	8.1 [a]	8.2 [a]	7.2 [a]	7.2 [a]	8.8 [a]	8.1 [a]
2.5 pH – preservative	7.8 [a]	6.8 [a]	8.0 [a]	8.0 [a]	7.2 [a]	7.3 [a]	8.5 [a]	8.5 [a]
3.0 pH + preservative	5.9 [c]	4.4 [c]	5.1 [c]	5.2 [c]	4.0 [c]	4.1 [c]	5.1 [c]	5.1 [c]
3.0 pH – preservative	5.9 [c]	3.4 [d]	5.2 [c]	5.2 [c]	4.1 [c]	4.1 [c]	5.2 [c]	5.2 [c]
Samples without corn syrup								
2.5 pH + preservative	7.1 [b]	6.1 [b]	6.5 [b]	6.6 [b]	6.0 [b]	6.0 [b]	6.9 [b]	6.5 [b]
2.5 pH – preservative	7.1 [b]	6.2 [b]	6.9 [b]	7.0 [b]	5.7 [b]	5.9 [b]	6.8 [b]	6.9 [b]
3.0 pH + preservative	4.3 [d]	3.4 [d]	3.2 [d]	3.3 [d]	3.0 [d]	3.0 [d]	3.3 [d]	3.5 [d]
3.0 pH – preservative	4.3 [d]	4.5 [c]	3.2 [d]	3.3 [d]	2.8 [d]	2.9 [d]	3.2 [d]	3.2 [d]

$LSD_{0.05}$: [w] Texture = 0.51 [x] Flavour = 1.19 [y] Overall acceptance = 1.12 [z] Acidity = 1.17

Table 2. Effect of pH on textural properties of Tamarind cheese during storage.

Treatment	Texture of Tamarind Cheese (mm / 2.5 seconds)									
	Day 1		Day 7		Day 14		Day 21		Day 28	
	20C	30C	20C	30C	20C	30C	20C	30C	20C	30C
	All with corn syrup and preservative									
2.5 pH	46	46	43	49	39	50	35	51	29	53
2.5 pH	47	48	44	50	40	53	37	54	34	53
2.5 pH	49	50	46	51	41	51	38	53	36	50
2.5 pH	50	51	47	52	42	52	39	54	37	51
3.0 pH	62	62	55	65	52	50	65	47	65	50
3.0 pH	64	64	60	65	55	65	52	64	46	50
3.0 pH	69	69	66	70	59	70	54	70	50	70
3.0 pH	71	71	70	73	62	72	56	73	53	73
$LSD_{0.05}$	2.99		2.42		1.56		2.02		3.85	

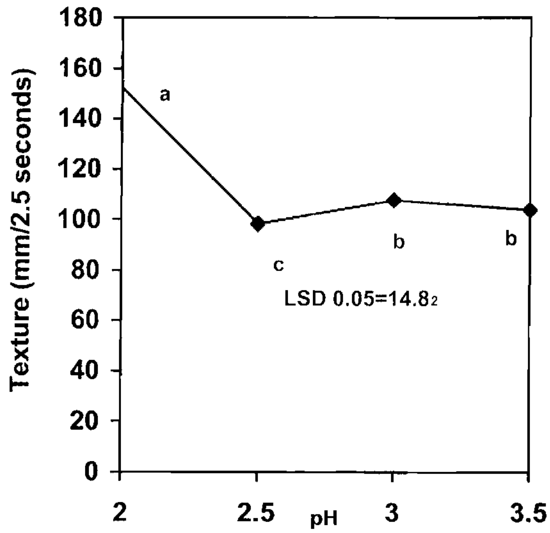

Figure 2. The effect of pH on the texture of tamarind cheese

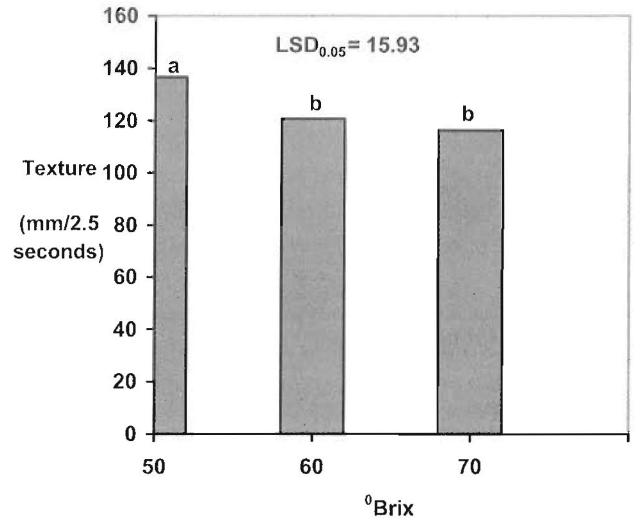

Figure 3. The effect of brix on the texture of tamarind cheese

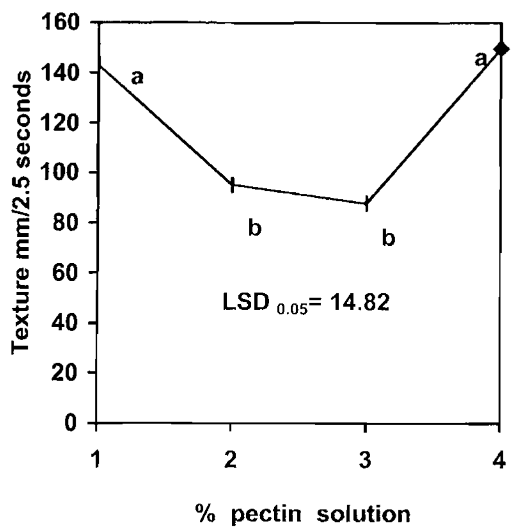

Figure 4. The effect of % pectin solution on the texture of tamarind cheese

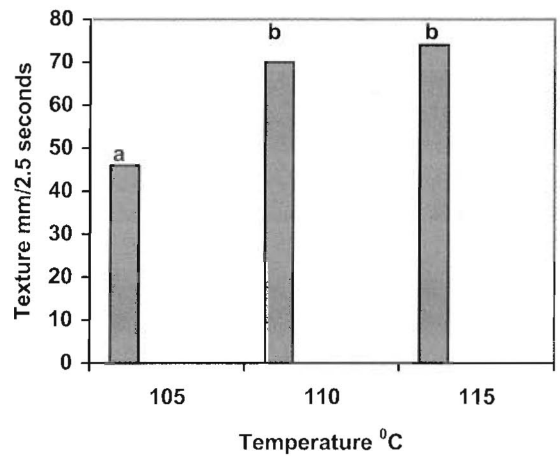

Figure 5. The effect of temperature on the texture of tamarind cheese