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# PHYSICOCHEMICAL AND SENSORY PROPERTIES OF PAWPAW (*Carica papaya* Linn) FLAVOURED YOGHURT

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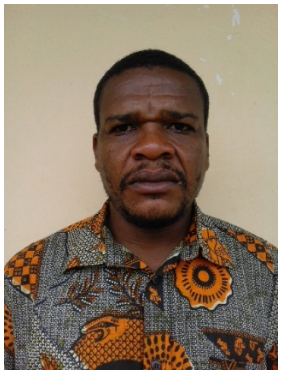

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**ABSTRACT**

Flavoured yoghurts are widely produced by using synthetic flavourings in Cameroon. However, the addition of fruits to yoghurt will impart natural flavours as well as contribute to the welfare of consumers by enhancing the nutritive and the functional properties of the yoghurt. This study was, therefore, aimed at evaluating the physicochemical and sensory properties of pawpaw (*Carica papaya* L.) flavoured yoghurt. Yoghurt was produced with the incorporation of pawpaw puree at four levels: 0% ($P_0$ as control), 5% ($P_1$), 10% ($P_2$) and 15% ($P_3$). The yoghurt samples were submitted to some physicochemical analysis (pH, titratable acidity, dry matter, moisture content, fat content, Solid-Non-Fat (SNF), sugar content and viscosity) on days 0, 7, 14, and 21 of storage. The sensory characteristics assessed by an untrained panel of 30 members were: flavour, colour, taste and texture. The pH of $P_0$ (5.01±0.04) and $P_3$ (4.99±0.04) and also the fat content of $P_0$ (3.4±0.17%) were significantly ($P\leq0.05$) higher compared to other samples. There was a reduction of fat content in yoghurt with an increase of pawpaw puree. Sugar content, SNF and viscosity of yoghurt increased significantly ($P\leq0.05$) with addition of pawpaw puree. Meanwhile, dry matter and titratable acidity were not significantly ($P\geq0.05$) affected. The titratable acidity of yoghurt $P_0$ and $P_3$ significantly ($P\leq0.05$) increased up to day seven of storage while pH was decreasing. From days 14 to 21, yoghurt $P_2$ and yoghurts $P_2$ and $P_3$ did not present significant ($P\geq0.05$) decrease of titratable acidity and pH, respectively. The fat content of $P_0$ and $P_1$, reduced significantly ($P\leq0.05$) the first week and the second weeks of storage, respectively, and then remained comparable ($P\geq0.05$) to the end of the storage period. There was no significant ($P\geq0.05$) difference in sensory properties of all the yoghurt treatments. In conclusion, the use of pawpaw to flavour yoghurt did not negatively affect the yoghurt properties; therefore, pawpaw flavoured yoghurt can be recommended for consumption.

**Keys words:** Flavoured yoghurt, pawpaw puree, physicochemical properties, storage, sensory properties

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## INTRODUCTION

Yoghurt is one of the most popular fermented dairy products widely consumed all over the world. It is the oldest, well-known, considered to be safe and highly accepted fermented milk product in the world due to its taste, perceived therapeutic activity and high nutritive value [1].

Yoghurt is produced by the fermentation of milk using a starter bacterial culture often comprising of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* [2, 3]. During fermentation, there is partial hydrolysis of fat, protein and lactose; therefore, yoghurt is easily digested compared to milk and is recommended for those suffering from lactose intolerance. The composition of yoghurt starter culture varies with the increasing industrial production according to nutritional needs and the functional foods phenomenon associated with species of live lactic acid bacteria and bioactive compounds [4-8].

The flavour of yoghurt is generated and imparted by the aromatic compounds which result from the fermentation process. However, flavour enhancement or diversification is common in yoghurt manufacture in order to present products that meet the taste of consumers of different cultural backgrounds. The extracted flavourings of fruits or the fresh fruits are incorporated in the yoghurt and this has led to the increase in per capita consumption of yoghurt in many countries.

Synthetic flavourings are mostly used in yoghurt production in Cameroon with the popular ones being vanilla, strawberry and pineapple flavours. However, the use of fruits as natural flavour will be of more benefit to the consumers. In addition to the flavour, fruits will enrich the yoghurt with bioactive compounds and nutritive elements. Besides, there has been increasing demand for a new range of dairy products, including yoghurts, which are similar to traditional products but have a low fat content [9].

Fruits are rich in sugar, dietary fibre, minerals and vitamins and generally low in fat content. They are a good source of natural antioxidants and dietary fibres, providing some of the bioactive substances required for the proper functioning of the human body [10].

In Cameroon, many fruits such as pineapple (*Ananas comosus*), banana (*Musa acumimata*) mango (*Mangifera indica*), pawpaw (*Carica papaya*) and guava (*Psidium guajava*) are cultivated and available. Some are seasonal while others are available throughout the year. Pawpaw is one of the fruits available in different varieties year round in various ecological zones of the country.

The pawpaw “solo” variety is the most marketable and widely cultivated variety in the country with a yield of about 60-80 t/ha and harvested over 22 months duration [11]. The fruit is highly perishable with considerable losses in the rainy season.

Flavouring yoghurt by the addition of pawpaw fruit is not a common practice, especially in Cameroon where synthetic flavours are favoured of fermented dairy

products. However, this fruit in addition to its natural flavour is endowed with a good amount of micronutrients and bioactive compounds, which could enrich the yoghurt rendering it a highly functional food [12 - 17]. Pawpaw is a rich source of enzymes known as papain and chymopapain which have antiviral, antibacterial and antifungal properties [15]. These enzymes also break down the proteins in food into amino acids and, therefore, help in digestion.

The objectives of this study is to evaluate the physicochemical and the sensory properties of the yoghurt flavoured with pawpaw puree, and the effect of pawpaw puree on the physicochemical properties of yoghurt during storage.

## MATERIAL AND METHODS

### Preparation of pawpaw puree

The red-fleshed ripe pawpaw (*Carica papaya* Linn, solo variety) fruits from Njombe (Littoral Region, Cameroon) were purchased from the Bamenda Food Market in the North-West Region, and brought to the Food Technology Laboratory of the Institute of Agricultural Research for Development (IRAD) - Bambui, Cameroon. The fruits were washed with potable water, peeled and sliced into small sizes of about 10-15mm and then a puree was prepared by blending in a heavy duty blender (Waring commercial, United Kingdom). Sugar (5% (w/w)) was added to the puree to enhance sweetness and preservation and after mixing thoroughly, the mixture was pasteurised by heating at 87-90$^{o}$C for five minutes, cooled rapidly and stored in the refrigerator until used.

### Preparation of yoghurt samples

Fresh cow's milk collected from the dairy unit of the research centre was used to produce four yoghurt samples. The yoghurt production technology was as described by Lee and Lucey [18] with some modifications. The milk was pasteurised by heating at 85-90°C for five minutes in a boiling water bath during which sugar was added at the rate of 6.5% (w/v). The milk was then rapidly cooled to inoculation temperature (42 – 45°C) followed by addition of 2.5% (w/v) yoghurt starter culture (CHR HANSEN YF – L811) comprised of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* in a 1:1 ratio. The pawpaw puree was then added and incubation at 42- 45°C lasted for three hours when the yoghurt was set. Four yoghurt samples were obtained as follows: $P_0$; $P_1$; $P_2$; $P_3$; with 0, 5, 10, and 15% of pawpaw puree (w/v), respectively. These samples were subjected to physicochemical and sensory evaluations.

### Physicochemical analysis

The physicochemical analyses were done in duplicate. The dry matter (DM), pH, titratable acidity (TA) and fat were determined according to the standard Association of Official Analytical Chemists (AOAC) methods [19], at seven days intervals for a 21 days' storage period under refrigeration conditions (4 – 6°C).

The Solid Non-Fat (SNF) was determined from the fat content following the formula: SNF (%) = dry matter (%) – fat content (%).

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The sugar content was measured at 20°C with the eclipse refractometer (Belligham + Stanley Ltd, United Kingdom) and the result given in Brix (% of sucrose).

The viscosity was determined with a viscosimeter and expressed in seconds needed for a ball to drop through yoghurt to the bottom of the viscosimeter.

**Sensory evaluation**

Sensory evaluation was carried out using a five-point hedonic scale with the following as categories: Excellent=5; Very Good=4; Good=3; Fair=2 and Poor=1. Colour (appearance), flavour (aroma), texture and taste of yoghurt samples were evaluated by an untrained panel of 30 persons between 20 and 60 years old.

**Statistical analysis**

Data obtained were subjected to the Analysis of variance (ANOVA) using the XLSTAT 7.52 version and the means were separated using the Fischer Test (LSD).

## RESULTS

**Physicochemical composition of pawpaw –flavoured yoghurt**

The results in Table 1 show the physicochemical composition of different yoghurt treatments produced. Addition of pawpaw puree decreased the pH of yoghurt except yoghurt $P_3$ (yoghurt with 15% of fruit puree). The pH of the control yoghurt (yoghurt with zero percent of pawpaw puree) and yoghurt $P_3$ which were 5.01±0.04 and 4.99±0.04, respectively, were comparable ($P \geq 0.05$) and significantly ($P \leq 0.05$) higher. The titratable acidity of all the yoghurt treatments showed no significant difference ($P \geq 0.05$) although the control yoghurt (1.19±0.01%) and yoghurt $P_3$ (1.26±0.03%) presented the lowest and the highest values, respectively.

The results revealed an increase of yoghurt dry matter with addition of the pawpaw puree but with no significant difference ($P \geq 0.05$) between treatments. The fat content was noted to reduce significantly ($P \leq 0.05$) with addition of pawpaw puree. The control yoghurt presented the highest amount of fat content (3.4±0.17%) while the yoghurt $P_3$ presented the lowest (2.76±0.15%). According to the FAO/WHO standards, the fat content of non-fat, low-fat and normal yoghurt is ≤ 0.5%, from 0.5 - 3.0% and >3.0%, respectively. Following this classification, samples $P_0$ (control yoghurt) and $P_1$ (yoghurt with 5% of pawpaw pure) are considered as normal yoghurts while samples $P_2$ (yoghurt with 10% of pawpaw pure) and $P_3$ (yoghurt with 15% of pawpaw pure) are considered as low-fat yoghurts. The results indicated an increase of Solid - Non – Fat (SNF) with addition of pawpaw puree. The control yoghurt with 13.21±0.21% presented the lowest value of SNF and this value was comparable ($P \geq 0.05$) to 13.69±0.33% presented by yoghurt $P_1$, but significantly different ($P \leq 0.05$) from the values of yoghurt $P_2$ and yoghurt $P_3$ (13.78±0.25 and 14.08±0.32%, respectively). The sugar content of samples $P_0$ (11.83±0.28°Brix) and $P_3$ (13.5±0.00°Brix) were significantly ($P \leq 0.05$) the lowest and highest values, respectively. In general, an increase in sugar content was observed with an increase in the percentage of pawpaw puree added during the yoghurt processing and this same trend was observed for the results of viscosity.

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**Change during storage of pawpaw flavoured yoghurt**

**Change of pH during storage of pawpaw puree yoghurt**

The figure below indicates that at days 0, 14 and 21, the yoghurts $P_0$ and $P_3$ presented the highest values of pH whereas on day seven, the pH values for all treatments were comparable ($P \geq 0.05$). The changes of pH observed during storage were not the same in all of the yoghurt treatments. For the samples $P_1$ and $P_2$, there was no significant difference ($P \geq 0.05$) of pH from day 0 to day 14 of storage but there was a significant ($P \leq 0.05$) decrease from day 14 to day 21. For the samples $P_0$ and $P_3$, the results indicated a significant reduction ($P \leq 0.05$) of pH during the first week of storage with a rising trend the next week. The initial pH values (day zero) of yoghurts $P_1$ and $P_2$ were different ($P \leq 0.05$) to the final pH values (day 21) and the opposite result was observed for samples $P_0$ and $P_3$.

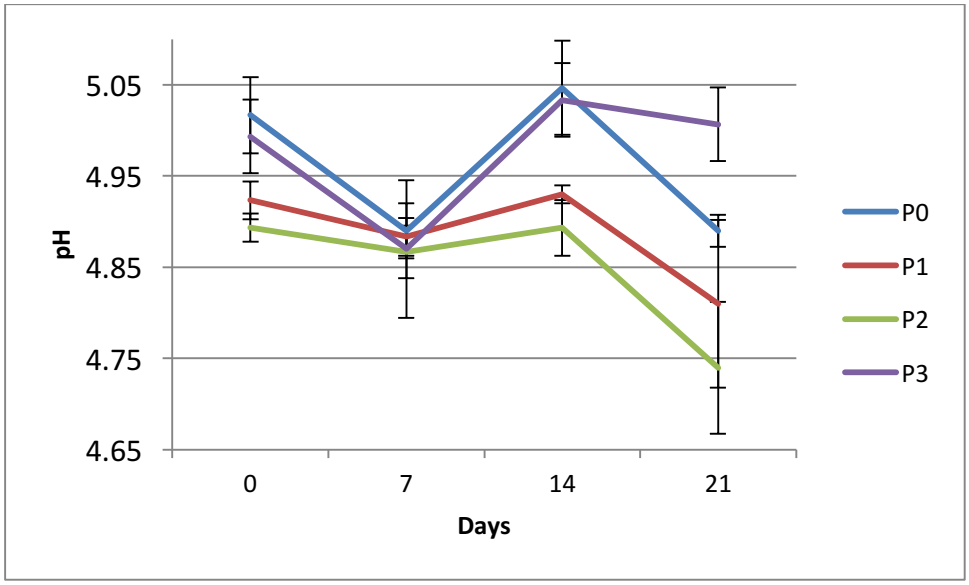


**Figure 1: Change of pH of yoghurt prepared with pawpaw puree during 21 days' storage**

**Change of lactic acid content during pawpaw puree flavoured yoghurt storage**

Figure 2 below reveals that sample $P_3$ presented significantly ($P \leq 0.05$) the highest lactic acid content (1.34%) at day seven. At day 21, sample $P_1$ presented the lowest value ($P \leq 0.05$) of titratable acidity (1.13%) while samples $P_0$ and $P_3$ with 1.20% and 1.22%, respectively, had significantly ($P \leq 0.05$) higher values of lactic acid content. The change of lactic acid percentage during storage showed a significant ($P \leq 0.05$) increase from day zero to day seven for samples $P_0$ and $P_3$, while only sample $P_2$ was not dropping significantly ($P \geq 0.05$) from day 14 to day 21. Therefore, there was no significant ($P \geq 0.05$) change between day seven and day 14.

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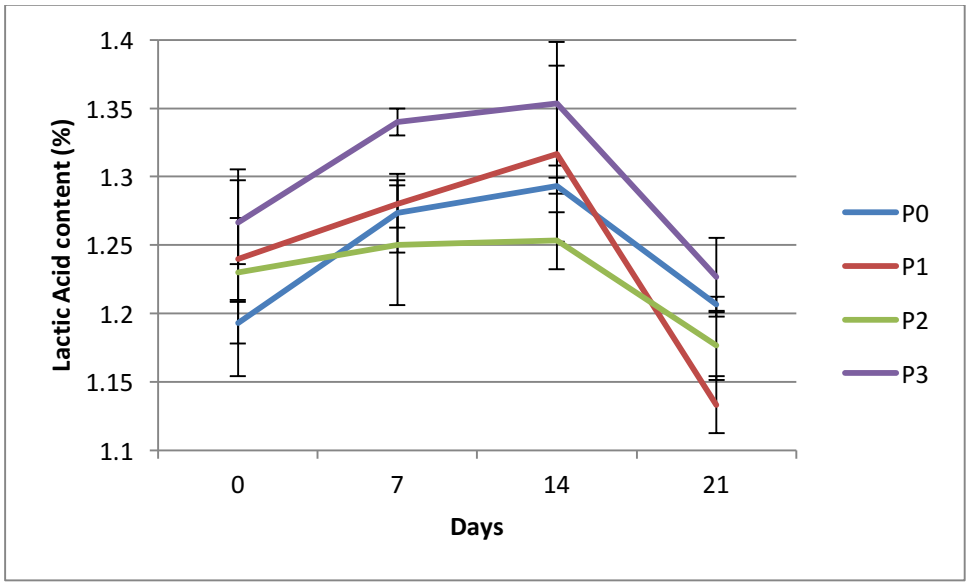


**Figure 2: Change in Lactic Acid content (%) of yoghurt prepared with pawpaw puree during 21 days' storage**

**Change of dry matter during storage of pawpaw puree flavoured yoghurt**

The change of dry matter during 21 days of storage of pawpaw puree flavoured yoghurt is presented in figure 3 below. It indicates that there was no significant difference ($P \geq 0.05$) in the dry matter among the yoghurt treatments during storage although; samples $P_2$ and $P_3$ registered the highest total solid content on day 21 of storage.

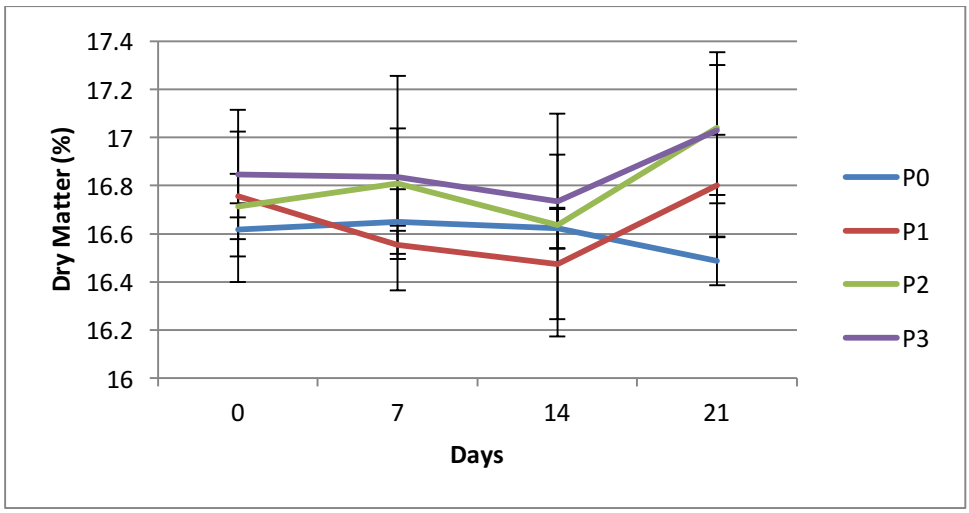


**Figure 3: Change of Dry Matter (%) of yoghurt prepared with pawpaw puree during 21 days' storage**

**Change of fat during storage of pawpaw puree flavoured yoghurt**

Figure 4 below presents the results obtained from fat analysis of yoghurt during storage. Yoghurt $P_0$ showed significantly ($p \leq 0.05$) the highest fat content on day 0 and

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day 21 while yoghurt $P_3$ presented the lowest value. In general, addition of pawpaw puree decreases the fat content of yoghurt. There was no significant ($P \geq 0.05$) change in fat content for yoghurts $P_2$ and $P_3$ during storage. On the other hand, there was a significant ($p \leq 0.05$) decrease of fat content for yoghurts $P_0$ and $P_1$ during the first and second weeks of storage, respectively.

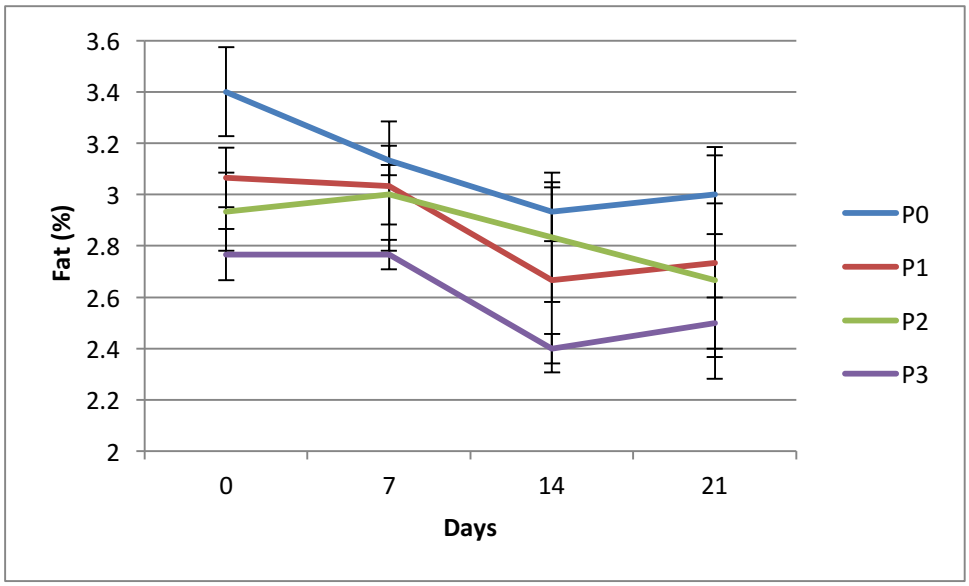


**Figure 4: Change in Fat content (%) of yoghurt prepared with pawpaw puree during 21 days' storage**

**Sensory evaluation**

The sensory evaluation scores of the yoghurt samples presented in figure 5 indicate that addition of pawpaw puree did not significantly ($P \geq 0.05$) affect the yoghurt flavour, colour, texture or taste. However, higher scores for all parameters were registered for yoghurt $P_1$, $P_2$ and $P_3$ when compared to yoghurt $P_0$ (control).

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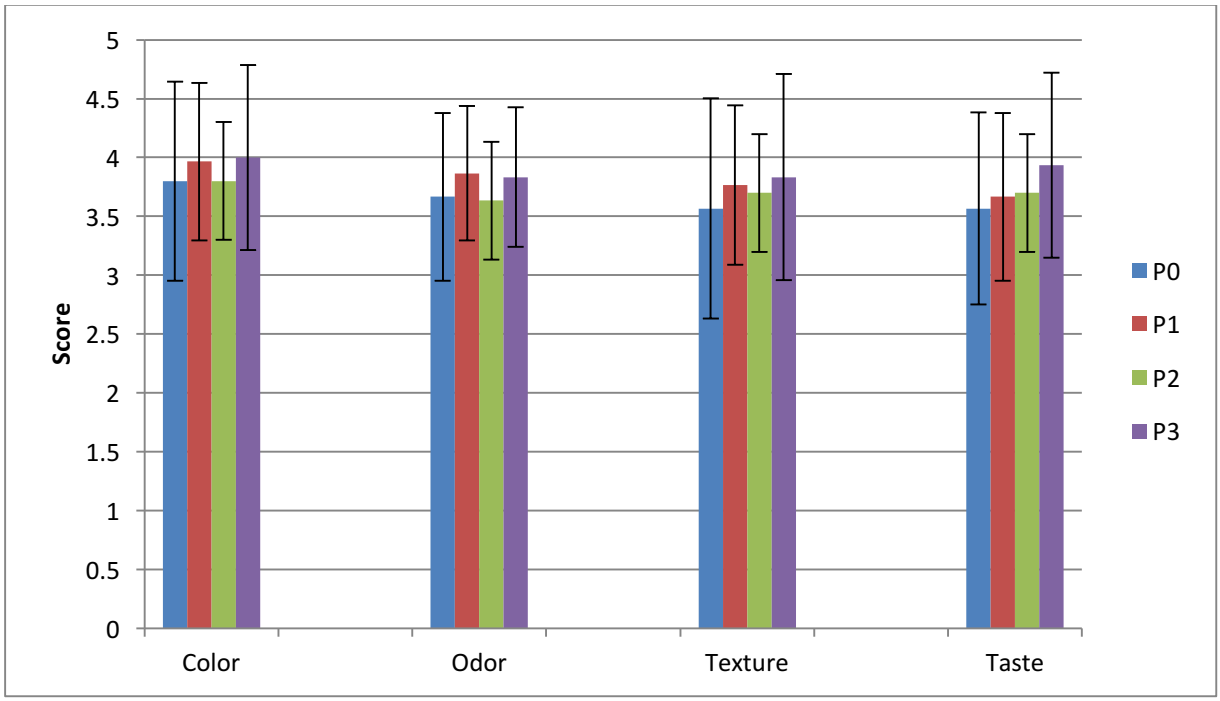


**Figure 5: Histogram of sensory attributes scores of yoghurt prepared with pawpaw puree**

## DISCUSSION

### Physicochemical composition of pawpaw flavoured yoghurt

The addition of pawpaw puree had no significant effect on the dry matter of yoghurt. These results are similar to those obtained for plain and fruit yoghurt samples collected from retail outlets in Sabaragamuwa Province of Sri Lanka [20]. In other studies, whereby banana, apple and strawberry marmalades were used in producing fruit yoghurts, an increase in the dry matter of the fruit yoghurt was observed when compared to plain yoghurt [21]. This difference observed may be due to the composition of the marmalade used which was made with 30% of sugar and 70% of fruit pulp. The dry matter values obtained in this study are lower than the average dry matter percentage of 20.11±2.77 obtained for ten artisanal yoghurts produced in Maroua, Far – North Region, Cameroon [22].

The reduction of pH observed with addition of pawpaw puree was expected because the addition of a sugar source (pawpaw puree is rich in sugar) may help lactic acid bacteria to produce more lactic acid during fermentation. The comparable pH values of samples $P_0$ and $P_3$ obtained may be related to the partial neutralisation of the acidity produced in $P_3$ during fermentation due to the higher amount of pawpaw with low acidity. The pH values were slightly higher than the normal pH of yoghurt (4.6) and the results of Yousef *et al.* [21] and Ponka *et al.* [22] which ranged between 4.1-4.8 and 3.67-4.30, respectively.

Pawpaw puree did not affect the titratable acidity of yoghurt. Some studies indicated a reduction [20] and others an increase [21] of titratable acidity in fruit yoghurt compared to plain yoghurt. Those differences can be due to the type of fruit and to the fruit preparation. The values of titratable acidity observed in this study were greater than the normal titratable acidity of yoghurt which is about 1% and were slightly higher compared to the values obtained by previous studies which ranged between 0.83-1.21percent [21].

Addition of papaw puree lowered the fat content of yoghurt. Other authors obtained the same variation from their work with addition of fruits in yoghurt processing [20, 21]. This may be widely due to the lower level of fat in fruits. The values obtained in this study are lower than those obtained by Yousef *et al.* [21] which ranged from 3.11 - 3.41% and are situated between 1.25 - 4.05% and 0.4 - 3.94 obtained by Ponka *et al.* [22] and De Silva and Rathnayaka [20], respectively.

The increase in SNF of yoghurt with addition of pawpaw puree observed could be explained by the fact that pawpaw contains more solid non-fat than fat. Thus, increasing the level of pawpaw puree during yoghurt making corresponded with the increase in SNF in yoghurt.

The increasing of yoghurt sugar content with addition of pawpaw puree can be related to the high percentage of sugar (glucose, fructose or sucrose) in fruits and the sugar (five percent) added during puree preparation. Previous studies also showed similar results [21].

The physicochemical composition of yoghurt depends generally on many factors including the milk composition and various additives used, the formulation of the manufacturer and the processing technology involved.

**Change during storage of pawpaw puree flavoured yoghurt**

The pH changes observed during storage is not consistent with the findings of other studies which did not indicate pH changes in yoghurt samples during storage at 5±2°C for a period of three weeks, but revealed a significant difference ($P \leq 0.05$) between the initial and the final value of pH across all samples [23]. Those studies were carried out with yoghurt without fruit and yoghurts with 10g of fruit (pineapple, mango and papaya) puree made with 20% of sucrose. Nevertheless, there is a similarity between the result of pH change during storage and the one of other authors who worked with concentrated probiotic yoghurt [24]. In fact, the decrease of the pH values of yoghurt, throughout its shelf life, may be due to the fact that the pH value of yoghurt depends on many factors including dry matter, nutrient composition and continued fermentation through the activity of lactic acid bacteria in yoghurt samples which continues during refrigeration conditions (low temperature).

The changes in titratable acidity observed during storage are consistent with the ones of some authors who obtained an increase in titratable acidity from the first to the sixth day of storage and no significant change from the sixth to the tenth day of storage [21]. Moreover, there was no significant difference between the titratable acidity of all the

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samples after the same duration of storage. Other authors indicated rather an elevation of lactic acid content at three weeks of storage [24]. The increase of lactic acid could be related to the microorganism activity which continues during storage. In fact, during post-acidification period, the activity of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* was not completely stopped due to the availability of nutrients in yoghurt. Seemingly, as sugar sources were depleted, microorganisms began to breakdown proteins leading to by-products which resulted in a decrease in acidity.

The reduction of fat content observed during storage for samples $P_0$ and $P_1$ can be attributed to the breakage of lipid during the fermentation process [25]. Pawpaw is rich in vitamin C which has antioxidant properties; this could explain the insignificant change observed in fat content during storage for samples $P_2$ and $P_3$ especially.

**Sensory evaluation**

Addition of pawpaw puree did not significantly affect the sensory properties of yoghurt according to the appreciation of panellists though yoghurts $P_1$, $P_2$ and $P_3$ registered slightly higher scores compared to the control. This result is similar to those obtained by previous studies [21]. A study done by Duangrutai [23] also indicated no significant difference ($p \geq 0.05$) on the sensory properties of yoghurt without fruit puree and the one with papaya (pawpaw) puree. Meanwhile, in the same study pineapple and mango had more effect on odour, flavour and overall preference of yoghurt compared to pawpaw.

## CONCLUSION

The results obtained show that pawpaw puree has no effect on the dry matter, titratable acidity and sensory properties (flavour, colour, texture and taste) of yoghurt. It rather reduces the fat content and increases the SNF, sugar content and viscosity of yoghurt. The variation of the dry matter of yoghurt during storage was not affected by the addition of pawpaw puree. At 5% and 10%, pawpaw puree did not affect change in pH and titratable acidity of yoghurt up to day 14 of storage. During storage, fat content of yoghurt was not affected by addition of pawpaw especially at 10% and 15%. Considering the fact that pawpaw did not negatively affect the sensory properties of yoghurt, pawpaw flavoured yoghurt can be recommended to consumers.

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**Table 1: General Physicochemical characteristics of pawpaw puree flavoured yoghurt**

| | Yoghurt treatments | | | |
|---|---|---|---|---|
| **Parameters** | **$P_0$** | **$P_1$** | **$P_2$** | **$P_3$** |
| pH | 5.01±0.04a | 4.92±0.02b | 4.89±0.01b | 4.99±0.04a |
| Lactic acid (%) | 1.19±0.01a | 1.24±0.03a | 1.23±0.07a | 1.26±0.03a |
| Dry matter (%) | 16.61±0.11a | 16.75±0.35a | 16.71±0.13a | 16.84±0.17a |
| Moisture (%) | 83.38±0.11a | 83.24±0.35a | 83.28±0.13a | 83.15±0.17a |
| Fat (%) | 3.4±0.17a | 3.06±0.05b | 2.93±0.11b | 2.76±0.15c |
| Solid Non-Fat (%) | 13.21±0.21b | 13.69±0.33ab | 13.78±0.25a | 14.08±0.32a |
| Sugar (°Brix) | 11.83±0.28c | 12.16±0.28c | 12.83±0.57b | 13.5±0.00a |
| Viscosity (s) | 1.28±0.10c | 1.74±0.13b | 2.04±0.13b | 2.45±0.23a |

*(a, b, c): the values with the same letters in the same row are not significantly different (P≥0.05)*

*$P_0$: Yoghurt with 0% of pawpaw puree* *$P_1$: Yoghurt with 5% of pawpaw puree*

*$P_2$: Yoghurt with 10% of pawpaw puree* *$P_3$: Yoghurt with 15% of pawpaw puree*

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