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ATTRIBUTES AND CONSUMER ACCEPTANCE OF YOGHURT FLAVOURED WITH NON – CULTIVATED INDIGENOUS SWAZI FRUITS

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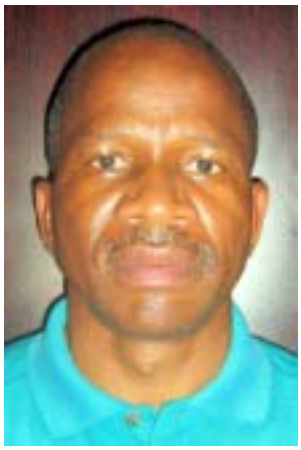

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ABSTRACT

The value of non-cultivated indigenous fruits as flavouring agents for yoghurt has not been given sufficient attention in Swaziland. Consequently, commercial cultivated fruits are used as yoghurt flavours, resulting in higher production costs for the dessert. A study of sensory and physical characteristics of yoghurt flavoured with selected non-cultivated indigenous fruits was done. Fruit purees were made from *tincozi*, *tineyi*, and *umfomfo*, along with mixtures of strawberry, *tincozi* and *tineyi*; *umfomfo* and strawberry; and *umfomfo* and passion fruit. The physico–chemical properties measured were pH, titratable acidity and potential for syneresis. Sensory evaluation was done by an untrained panel consisting of available, local consumer folks used to doing sensory evaluation and the organoleptic characteristics assessed were appearance, texture and general acceptability. In all cases there were no significant ($P > 0.05$) changes in pH after 7 days of storage at 4^{o}C. Using indigenous fruit purees did not negatively affect the titratable acidity content of yoghurt. Indigenous fruit flavoured yoghurt had a lower acidity than plain and strawberry flavoured yoghurt. Using indigenous fruits as flavouring agents reduced potential for syneresis significantly ($P < 0.05$) from between 50 and 60% (w/v) in strawberry and plain yoghurt, respectively, to about 30% in indigenous fruits flavoured yoghurt. The highest preference (7.53) was given to the appearance of the strawberry flavoured yoghurt and appearance of the tincozi was rated lowest (5.57). Strawberry flavoured yoghurt was more highly rated than indigenous fruits flavoured yoghurt in all the sensory attributes. This was attributed to the fact that the panellists were more likely to be more accustomed to strawberry flavour and they presumably were less accustomed to the indigenous fruits that had never been used in yoghurt production before. Mixing indigenous fruits with cultivated exotic fruits such as strawberry and passion fruits improved the acceptability of the indigenous fruit flavourings. It was concluded that indigenous fruits can be successfully used as yoghurt flavours, and this may improve the texture of the yoghurt and most probably lower its consumer price. A similar study targeting the rural community could be done to confirm findings from this study.

Key words: Indigenous fruits, yoghurt, sensory evaluation.

INTRODUCTION

Yoghurt is the most widely consumed fermented dairy dessert world-wide [1]. It is consumed by people of all ages including pre-school children and expectant mothers. It is also consumed by people of variable physical status, from the youthful athlete to the old and infirmed adult [2, 3]. Traditionally, yoghurt is prepared by fermenting milk using two symbiotic bacteria, *Streptococcus salivarius* ssp *thermophilus* and *Lactobacillus delbruckii* ssp *bulgaricus* [4]. The nutritional and health benefits of yoghurt are numerous. It is a good source of proteins, energy (calories), vitamins and minerals. As a fermented product, it may also have therapeutic value and may also result in reduced incidences of lactose intolerance [3, 5].

The fermentation of milk to yoghurt takes a relatively short period of time, 3-4 hr, because it is done at a higher temperature, 42 - 46^{o}C and also uses cultures that have fast growth rates. The major fermentation product is lactic acid, which is responsible for coagulation of the milk caseins. Other metabolites that are responsible for the yoghurt flavour are also produced during the fermentation and these include diacetyl, acetaldehyde and acetone [6, 7]. Fruits are added to the fermentation media to enhance organoleptic properties [8, 9]. In stirred yoghurt, fruits are added post fermentation and in set yoghurt, they are added prior to the fermentation [1, 9]. It is always necessary to determine the sensory attributes of a product whenever new ingredients are used [10, 11].

In Swaziland, like in many sub-tropical countries, commercial cultivated fruits are used to flavour yoghurts. These include strawberries, bananas, peaches, mandarins, and passion fruits. No studies have been done to investigate the use of non-cultivated indigenous fruits as yoghurt flavours. Swaziland has numerous indigenous fruits that are in abundance during their growing season [12]. The potential of using these non-cultivated indigenous fruits as flavouring agents for yoghurt warrants investigation. It is envisaged that if suitable, these fruits can be used to lower production costs of the yoghurt, thus enhancing its consumption among low income groups. It is anticipated that the use of indigenous natural flavours may enhance acceptance of yoghurt by consumers in the rural sector in particular, thus improve its consumption [13].

Sensory evaluation is an integral part of product development. As reported elsewhere, preference for food items by consumers may depend on a successful combination of sensory properties such as taste, smell, texture and appearance [9, 13, 14]. The indigenous fruits used in this study were chosen because they either resembled commercial cultivated fruits that are already established as flavouring agents or were special flavours that are generally liked by the Swazi people. Botanical descriptions of the indigenous fruits used have been described previously [12]. *Umfomfo* (*Cephalanthus natalensis*) fruits resemble strawberries in appearance but have a sour taste. The fruits are dry soft compounds that are white tinged with pink colour [12]. *Tineyi* (*Phyllogeiton zeyheri*), formerly known as *Rhamnus zeyheri*, have small oval red fruits. The fruits have a sweet taste and scent that is especially liked by the Swazi people. *Tincozi* (*Syzygium cordatum*) fruits are fleshy purple fruits that resemble grapes in that they have plenty of pulp and small seeds. This work was carried out to

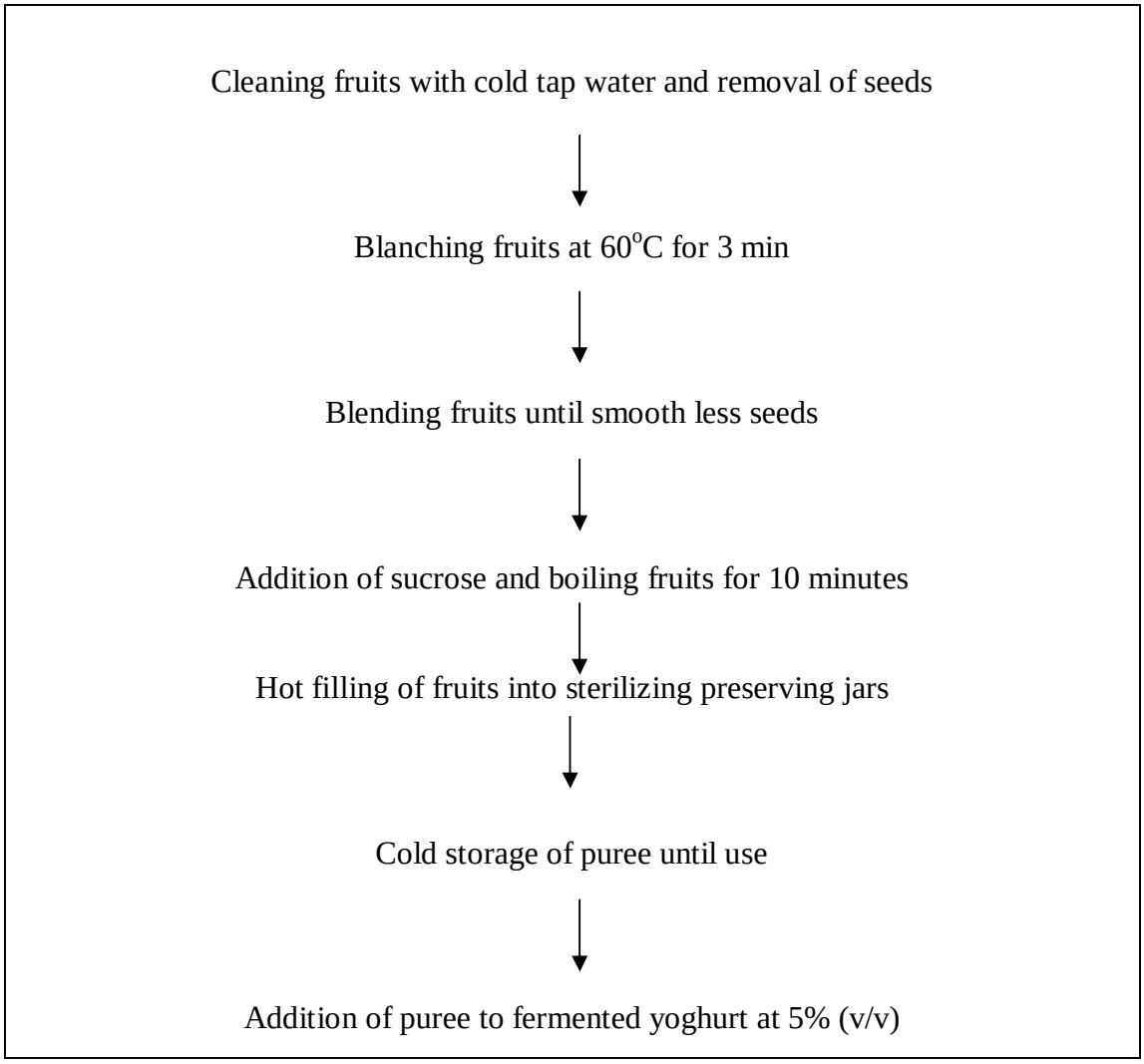
determine the acceptability of yoghurt flavoured with indigenous fruits. This information is vital because if indigenous fruits can be successfully used as yoghurt flavours, the texture of the yoghurt may be improved while the consumer costs could be kept lower since these fruits are not cultivated but are freely found in the wild.

MATERIALS AND METHODS

Preparation of fruit purees

The fruits were prepared into fruit purees as shown in figure 1 and the purees were used for flavouring the yoghurt. *Umfomfo* (*Cephalanthus natalensis*) fruits were picked from the highveld of Swaziland in the bushes of Mbuluzi and Mhlambanyatsi. The unripe fruits are green in colour; they then gradually turn pink and finally are white when fully ripened. The whole fully ripe fruits were used in this project. *Tineyi* (*Phyllogeiton zeyheri*) were procured from Sithobeleni – Sphofaneni area in the lowveld. The fruits are green when unripe and red when fully ripe. The seeds were removed from the fully ripe fruits and the flesh was used in this project. *Tincozi* (*Syzygium cordatum*) fruits were procured from the Usuthu basin in the highveld. Unripe fruits are hard and green. Fully ripe fruits are purple and soft. The soft *tincozi f*ruits were used in this project after removal of the seeds. Strawberry and passion fruit were purchased from Pick 'n Pay hypermarket, Ezulwini valley, Swaziland. The whole fully ripe strawberry fruits were used and the shells were discarded before the inner contents and gelatinous flesh of the passion fruits were used. In all instances, purees were prepared from fully ripe fruits blanched at 60^{o}C for 3 min followed by blending into a paste using a blender (Bar Mixer No. 92, Hamilton Beach USA).

Figure 1: Flow chart of steps involved in the preparation of fruit puree for yoghurt flavouring



To be consistent with typical cottage yoghurt production practices in Swaziland, 5% (w/v) sucrose was added to improve sweetness of the purees before they were heated at 100°C for ten minutes. Titratable acidity and pH conditions of the purees were determined as described before [15] and are presented on Table 1. Fruit purees were hot filled in sterilizing preserving jars and kept at 4°C until used.

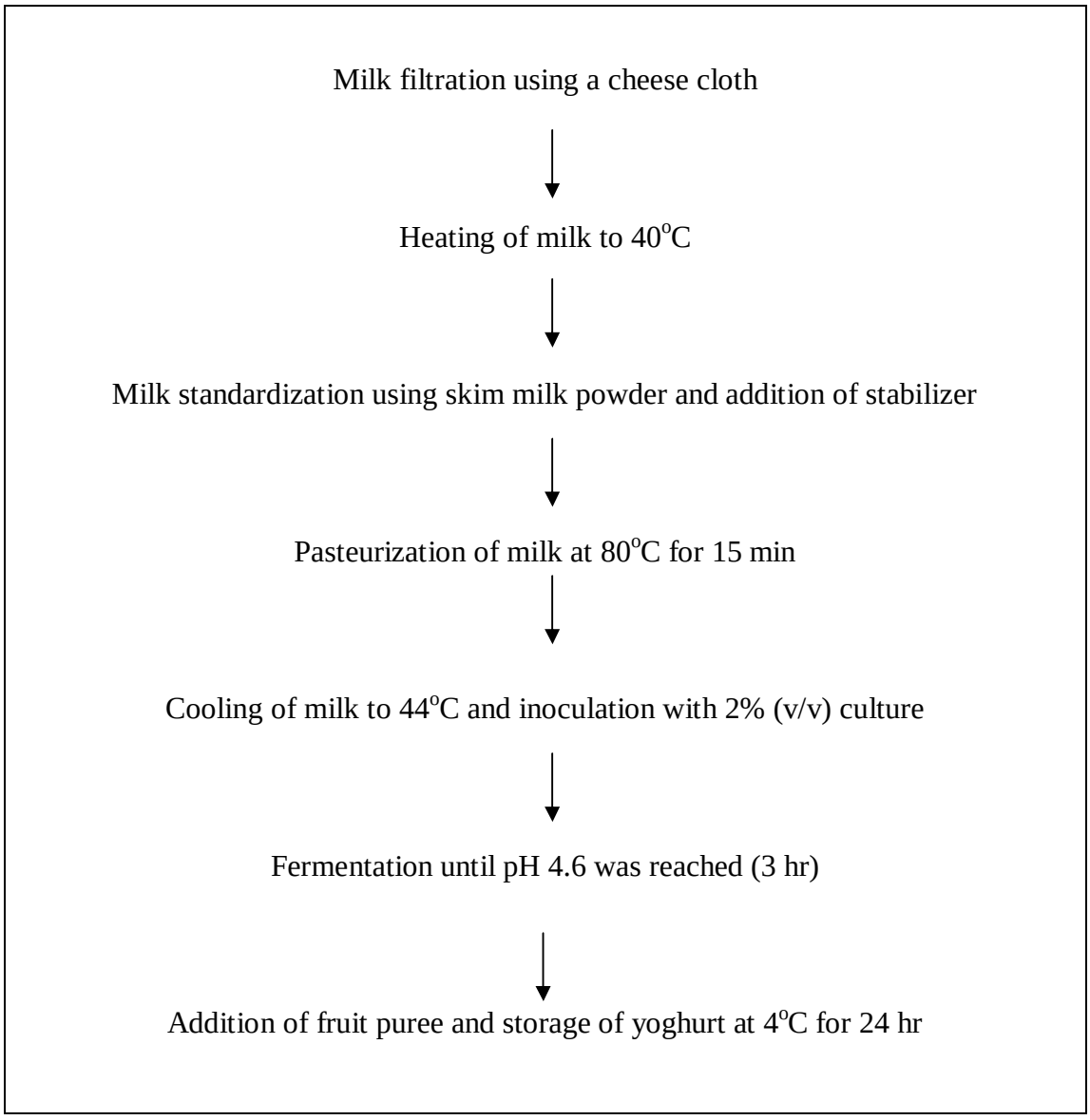
Production of yoghurt

Yoghurt was prepared from whole milk that had been standardized with skim milk powder to adjust the total solids to 15% (w/v) as shown on Figure 2. The amounts of each constituent were determined by the Pearson Square Method as described before [16, 17]. Gelatine stabilizer (0.25%, w/v) sourced from Leiner Davis Gelatine SA Krugersdorp was also added at 40°C as described before [18] and the mix was pasteurized in a water bath (Labotech 9090 model 132 SA) at 80°C for 15 min. After

pasteurization, the mix was rapidly cooled in ice chilled water to 44^{o}C and then inoculated with 2% (v/v) yoghurt culture of *Streptococcus salivarius* ssp *thermophilus* and *Lactobacillus delbruickii* ssp *bulgaricus.* The starter was prepared as a 1:5 (w/v) dilution of freeze dried thermophilic lactic yoghurt culture (YC 470 CHR Hansen, SA) in sterile skim milk. Fermentation was done in an incubator (Labotech EcoTherm^{e} 240L model 223, SA) at 44^{o}C and was stopped when the pH (Hyperscan model 510 pH meter) was 4.6. The purees of the indigenous fruits and the commercial cultivated fruit flavours were mixed with yoghurt at a rate of 5% (w/v) immediately after fermentation to give seven flavour treatments and one control. Some of the fruits flavours were mixed at a 1:1 ratio to get two fruit blends.

The treatments were given random three digit codes and were as follows: *tincozi; tineyi; umfomfo*; strawberry; *tincozi/tineyi; umfomfo*/strawberry; *umfomfo*/passion fruit. The control was plain yoghurt. Both the control and treatments were dispatched into 2 litre sterile containers. The yoghurts were stored at 4^{o}C for 24 hr and 7 days. The experiment was repeated three times at intervals of four weeks. Each time when the experiment was done pH, syneresis and sensory evaluation were determined.

Figure 2: Flow chart of steps involved in the production of yoghurt



Determination of pH and potential for syneresis

The pH of the yoghurts were determined after 24 hr and 7 days storage at 4°C using a Hyperscan model 510 pH meter. The potential for syneresis was determined by measuring expressible moisture from the gel using a method described before [4]. A sample of 40 g was taken from each type of yoghurt and was centrifuged (Kobota 2010 Hert 50, 60 Japan) at 10 000 x g for 20 minutes. Whey was drained for 30 min using a filter paper (MN 615, 90mm Germany) and then weighed. Potential for syneresis was calculated as the percentage of drained whey from the centrifuged sample.

Sensory evaluation

The sensory attributes of the yoghurts were evaluated by 40 panellists consisting of two food science lecturers, two food science technicians, 34 food science students from the University of Swaziland and two commercial producers of yoghurt. This was an untrained panel consisting of available, local consumer folks used to doing sensory evaluation. The assessors were presented with 30 mL of each sample at room temperature (25^{o}C). Water was given to the assessors for palate cleansing between samples. Permission to conduct the study was granted by the University of Swaziland Research Board and consent was sought from the participants after the objectives and methodology of the research had been explained to them. The sensory attributes evaluated were: flavour, appearance, texture and general acceptability. Textural attributes studied were: firmness, smoothness and viscosity [9, 13]. Sensory evaluation was done on yoghurt that had been stored for 24 hr and 7 days at 4^{o}C. This was repeated three times using the same panellists to ascertain consistency. An eight point hedonic scale (Table 2) was used to determine the responses of panellists on each attribute where 8 was *like extremely* and 1 was *dislike extremely* [13].

Statistical analysis

Data were analyzed using the statistical software MSTAT-C (Micro Soft Corporation Inc. 2003). Data were also subjected to analysis of variance and Duncan's New Multiple Range Test for comparisons of means. Differences were accepted as significant at $P < 0.05$.

RESULTS

Results of the pH of the yoghurt enriched with various indigenous fruits are presented in Table 3. The pH was measured after 24 hours and at 7 days of cold storage. There was no significant difference ($P > 0.05$) in pH among the yoghurt treatments. It was, however, noted that the pH for strawberry flavoured yoghurt (commercial brand) was slightly lower (4.15) after 24 hours of storage. It was also observed that after 7 days storage the pH from the *umfomfo*/strawberry blend was lowest at 3.94. Based on these results, a qualitative observation for all yoghurt samples was that the pH decreased slightly as a result of storage.

The results presented in Table 4 show that all indigenous fruits flavoured yoghurts had significantly ($P < 0.05$) lower potential for syneresis than the plain and strawberry flavoured yoghurt. Whey separations observed in strawberry (60%), strawberry/*umfomfo* (49%) and in plain yoghurt (47%) were significantly ($P < 0.05$) higher than in the yoghurt flavoured with indigenous fruit (30%).

Table 5 presents the results of sensory evaluation by the panellists over three replications. High mean values were obtained for the strawberry flavoured yoghurt (>7.0) and the strawberry/umfomfo yoghurt (>6.0) for all sensory attributes. Tineyi fruit flavoured yoghurt had the highest mean for general acceptability compared to the other indigenous fruit flavours (5.81) and was third in overall preference. Low means were observed in umfomfo flavoured yoghurt for flavour (4.47) and for general

acceptability (4.25). There were also low means in plain yoghurt for general acceptability (4.89). Overall the mean values for sensory attributes of all indigenous fruit flavoured yoghurts were less than *dislike slightly* (4.0). The results presented in table 5 also show that the acceptance of strawberry flavour by panellists was significantly ($P < 0.05$) higher than any of the undomesticated indigenous fruit flavours.

DISCUSSION

Addition of indigenous fruits flavours lowered the pH of yoghurts slightly. Indigenous fruits flavoured yoghurt had slightly lower pH values than plain yoghurt, particularly after 7 days storage. This could be attributed to the titratable acidity of the indigenous fruits purees. Previous studies have also shown that the trend in yoghurt production is that organic acids increased during the fermentation process and storage [3, 17]. Results from this work have shown a slight increase in titratable acidity of the yoghurt after 7 days storage at 4^{o}C. Results presented in this work have also shown that *umfomfo* purees, that had higher titratable acidity, produced yoghurts that had a lower pH than the other indigenous fruits.

The results overall indicated that using indigenous fruits as flavours resulted in a slight increase in the acidity of yoghurts. However, this slight increase was still within the acceptable pH 4.0 for yoghurt. This was confirmed by the higher acceptability of strawberry flavoured yoghurt despite its pH being slightly lower than that of most indigenous fruits flavoured yoghurt. Results presented in this work have also shown that flavouring with indigenous fruits did not result in detrimental increases in acidity as can be seen by the comparatively higher pH in indigenous fruit flavoured yoghurt than in strawberry flavoured and plain yoghurt.

As reported elsewhere, increases in acidity might be perceived as a negative attribute in yoghurt processing if the acidity results in very low pH values, below pH 3.5 [9, 19]. Results presented in this study have shown that this did not occur. This is confirmed by the observation that the non-cultivated indigenous fruit flavours had slightly higher pH values than either strawberry flavoured (commercial) yoghurt or plain yoghurt. Results presented in this work, however, have also indicated that acidity may increase more variably with storage of indigenous fruit flavoured and plain yoghurt than when strawberry flavoured yoghurt is stored. This may be attributed to increases in organic acids production during storage as suggested by other studies [17]. However, this observation may warrant further investigation.
Syneresis is not desirable in yoghurt. Good quality yoghurt should have strong gels that have no whey separation [4]. Results presented in this study have shown that flavouring the yoghurt with indigenous fruits reduced the potential for syneresis (Table 4). The indigenous fruits prevented the potential for syneresis better than the commercial (strawberry) flavoured yoghurt or plain yoghurt. This may indicate that indigenous fruits may improve the texture. This might be attributed to pectic substance being present in the indigenous fruits that may give body to the yoghurt [2]. Previous reports have also shown that the presence of biopolymers in yoghurt mixes improves the texture of yoghurts, a desirable characteristic for yoghurt quality [20,

21]. The advantage of improving the texture of the yoghurt using the indigenous fruits compared to using stabilizers alone is in the enhancement of flavour. This is paramount because, as reported before, using stabilizers alone in yoghurts may adversely affect its organoleptic properties [20]. The results presented in this work have shown that using indigenous fruits as flavouring agents may improve textural properties of yoghurt.

Sensory evaluation results (Table 5) have shown that there is significant ($P<0.05$) variation in preferences of sensory attributes by the panellists. The results have shown that the appearance of strawberry flavoured yoghurt was highly preferred (7.53). *Tincozi* flavoured yoghurt was the least preferred (5.57). One possible reason for this could be that the indigenous fruit flavoured yoghurt had a darker colour than the strawberry flavoured yoghurt that was brighter. This may indicate that the untrained consumer panel preferred brighter coloured yoghurts. This point can also be supported by the observation that panellists ranked *tineyi* flavoured yoghurt, made of bright cherry red fruits highest in general acceptability of the indigenous fruits flavoured yoghurts. Another possible reason could be that the strawberry flavour is an already established commercial flavouring agent for yoghurt, and hence the consumers could be familiar with it [14].

In general, strawberry yoghurt was more highly rated than indigenous fruits flavoured yoghurt in all the sensory attributes (flavour, texture and general acceptability). This could be attributed, as mentioned previously, to the observation that the panellists were more likely to be more accustomed to strawberry flavour and they presumably were less accustomed to the indigenous fruits that had never been used in yoghurt production before. It was noted, however, that for all the attributes, none of the indigenous fruit flavours were rated below 4.0, on an 8 point scale, thus indicating that the fruits were not *disliked* [13, 14]. In an African country like Swaziland, yoghurt flavoured with commercial cultivated fruits like strawberry, is a common dessert in the urban community yet the non-cultivated indigenous fruits are consumed mostly in the rural community. This may mean that the panellists used in this study were less familiar with the indigenous fruits, as they were mostly urban based, hence they had less interest in the indigenous fruit flavoured yoghurts

Since this study was done in an urban community, a comparison with responses from the rural community will be of great interest. These results have also shown that mixing indigenous fruits with domesticated exotic fruits such as strawberry and passion fruits improved the acceptability of indigenous fruit flavouring.

CONCLUSION

The results from this work have shown that indigenous fruits might be used as fruit flavours for yoghurt. There was reduced potential for syneresis in yoghurt flavoured with indigenous fruits. This indicated an improvement in texture by the use of indigenous fruits as flavouring agents. There were significant ($P < 0.05$) differences in general acceptability of yoghurt flavoured with all the indigenous fruits except umfomfo that was less preferred than unflavoured yoghurt. However, all the

indigenous fruits were less acceptable than the commercial yoghurt flavour, strawberry. As none of the yoghurts flavoured with undomesticated fruits were *disliked*, it is concluded that these indigenous fruits might be successfully used as yoghurt flavours, and this may lower the market price for this dessert, thus improving its accessibility to the lower income urban and peri-urban communities. It is recommended that a similar study targeting the rural community be done to confirm the findings of this study.

Table 1: Titratable acidity and pH of indigenous fruits purees

Indigenous fruit puree	pH	Titratable acidity (%)
Tineyi	5.12 ± 0.02	0.95 ± 0.02
Tincozi	4.80 ± 0.23	1.39 ± 0.01
Umfomfo	3.14 ± 0.06	2.39 ± 0.02
Strawberry	3.50 ± 0.01	1.61 ± 0.03
Passion fruit	3.2 ± 0.03	2.14 ± 0.03
Umfomfo/strawberry	3.37 ± 0.01	2.02 ± 0.03
Umfomfo/passion fruit	3.19 ± 0.01	2.34 ± 0.04

Results are averages of 6 replicates ± 1 standard deviation

Table 2: Hedonic scale used for sensory testing

Score	Quality characteristic
8	*Like extremely*
7	*Like very much*
6	*Like moderately*
5	*Like slightly*
4	*Dislike slightly*
3	*Dislike moderately*
2	*Dislike very much*
1	*Dislike extremely*

Table 3: The pH of yoghurt flavoured with various indigenous fruits when fresh and after 7 days storage at 4°C.

Yoghurt flavour	Yoghurt after 24 hours	Yoghurt after 7 days
Plain	$4.23^{ns} \pm 0.011$	$4.07^{ns} \pm 0.011$
Tincozi	$4.45^{ns} \pm 0.016$	$4.15^{ns} \pm 0.019$
Tineyi	$4.44^{ns} \pm 0.011$	$4.29^{ns} \pm 0.016$
Umfomfo	$4.35^{ns} \pm 0.011$	$4.16^{ns} + 0.016$
Strawberry	$4.15^{ns} \pm 0.016$	$4.14^{ns} \pm 0.008$
Tincozi/tineyi	$4.4^{ns} \pm 0.016$	$4.21^{ns} \pm 0.016$
Umfomfo/strawberry	$4.21^{ns} \pm 0.011$	$3.94^{ns} \pm 0.012$
Umfomfo/passion fruit	$4.23^{ns} \pm 0.016$	$4.1^{ns} \pm 0.016$

Results are averages of 6 replicates ± 1 standard deviation
ns = Means in the same column are not significantly different (P > 0.05) as determined by the Duncan's New Multiple Range Test

Table 4: Syneresis of yoghurt flavoured with indigenous fruits.

Yoghurt Flavour	Syneresis % (w/v)
Plain	$46.6^{b} \pm 2.4$
Tincozi	$28.8^{a} \pm 3.3$
Tineyi	$32.8^{a} \pm 4.8$
Umfomfo	$30.2^{a} \pm 1.5$
Strawberry	$60^{c} \pm 3.8$
Tincozi/tineyi	$30.2^{a} \pm 1.5$
Umfomfo/strawberry	$49.4^{b} \pm 2.9$
Umfomfo/passion fruit	$29^{a} \pm 2$

Results are averages of 6 replicates ± 1 standard deviation
Done over the 3 different batches of each yoghurt
Means followed by the same letter are not significantly (P > 0.05) different as determined by the Duncan's New Multiple Range Test.

Table 5: Ranked mean scores of sensory evaluation parameters of yoghurt flavoured with indigenous fruits.

Fruit Flavour used (code)	N	Appearance	Flavour	Firmness	Smoothness	Viscosity	General Acceptability
Plain (205)	120	5.99^{c}	5.04^{e}	6.40^{bc}	6.73^{b}	6.06^{c}	4.89^{e}
Strawberry (170)	120	7.53^{a}	7.66^{a}	7.28^{a}	7.52^{a}	7.15^{a}	7.67^{a}
Tincozi (105)	120	5.57^{e}	5.67^{d}	6.19^{cd}	5.85^{cd}	5.95^{cd}	5.77^{c}
Tineyi (305)	120	5.65^{e}	5.56^{d}	6.12^{cd}	6.09^{c}	5.86^{cd}	5.81^{c}
Umfomfo (211)	120	5.67^{e}	4.47^{f}	5.30^{e}	5.46^{e}	5.84^{cd}	4.25^{f}
Tincozi/ Tineyi (315)	120	5.72^{de}	6.16^{c}	5.37^{e}	5.72^{de}	5.35^{e}	5.60^{c}
Umfomfo/ Strawberry (207)	120	6.49^{b}	6.51^{b}	6.59^{b}	6.02^{cd}	6.37^{b}	6.38^{b}
Umfomfo/ Passion fruit (331)	120	6.09^{c}	5.77^{d}	6.00^{d}	5.92^{cd}	5.71^{d}	5.24^{d}

Means in the same column followed by the same letter are not significantly different ($P > 0.05$) as determined by the Duncan's New Multiple Range Test.

Rating scale:
8.0 = *Like extremely*; 7.0 = *Like very much*; 6.0 = *Like moderately*; 5.0 = *like slightly*; 4 = *Dislike slightly*; 3.0 = *Dislike moderately*; 2.0 = *Dislike very much*; 1.0 = *Dislike extremely.*

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