Table 2: Mean scores of sensory evaluation of the formulated OFSP based juice drink

Formulation	Flavor	Appearance	Taste	Body	Overall acceptability
F1	8.23±0.89^{a}	7.20±1.03^{a}	6.87±1.56^{a}	7.10±1.56^{c}	7.33±0.71^{bc}
F2	7.23±0.97^{a}	7.57±0.77^{ab}	6.93±0.94^{b}	7.00±1.46^{d}	7.13±0.97^{a}
F3	7.30±1.37^{c}	7.27±0.94^{a}	7.13±1.36^{a}	7.23±0.97^{b}	7.30±0.92^{d}
F4	7.63±1.03^{b}	8.30±0.54^{a}	8.30±0.84^{a}	8.30±0.70^{a}	8.70±0.54^{ab}
F5	7.10±1.61^{d}	7.37±1.61^{a}	6.37±1.63^{c}	6.87±1.61^{a}	6.00±1.93^{e}

Values ± SD with the same super script in the same column are not significantly different while those with the different super script letters are significantly different at p≤0.05.

3.1.4 Body/mouth feel

The term body describes the physical properties like; heaviness, thinness, oiliness, graininess, or wateriness of the juice as it settles on your tongue [17]. Discerning body involves identifying its tactile impression, consistency and weight as perceived in the mouth at the back of the tongue when you swoosh the juice around in your mouth and also after swallowing or after spitting the juice out [17]. Results in this study (table 2) showed that there was a significant difference between formulations F1and F2, F2 andF3, and F1 and F3 *(P≤0.05)*. But there is no significant difference seen between formulations F4 and F5 with the rest of the formulations *(P≤0.05)*. There was a high preference for the body of formulation F4 followed by F3, F1.F2 and F5 was liked least. It was also observed in the study that the higher the OFSP extract content, the lighter the formulation's body. This might be attributed to the fact that the OFSP juice had a light body and also the TSS contributes to the body of the juice. The preparation method of the juice drink could also be a factor that affected the body due to the amount of water added during processing. The amount of water added during preparation might have contributed to the light body of the formulations [19].

3.1.5 Overall acceptability

There was a significant difference in the overall acceptability between formulations F3 and F5 (p≤0.05) but there was no significant difference between formulations F1, F2 and F4 with the rest of the formulations (P≤0.05). The preference for formulation F4 was highest followed by F3, F1, and F2 and least for F5 as shown in table 2. The high acceptability scores (8.70±0.535) of F4 could be attributed to the substantial proportions of the pineapple juice as it has better sensory attributes particularly taste, body and flavor. The high proportion of OFSP contributed to the color then the other attributes for which the OFSP juice was inferior were improved on by the blending in the pineapple thus contributing to the ultimate acceptability of the formulation (F4).

3.2 The Results of the Physico-Chemical Characteristics of the Most Acceptable Formulation

3.2.1 pH

Results in this study indicated that the drink had a pH of 4.9 (Table 3).

Table 3: Physico-chemical characteristics of the most accepted formulation (F4)

Constituent	Mean value*
pH	4.9±0.10
Total soluble solids (%)	8.0±0.00
Titratable acidity (g/ml)	1.4±0.06

*All values are means of triplicate determination ± SD.

The mean pH of 4.9±0.10 indicated that the juice drink was slightly acidic compared to the pH of other fruit juices like pineapple juice which has a pH range of 3.0-3.1, and watermelon 5.2-5.8 [17]. The high pH might have an implication on the keeping quality of the juice because the high pH would proliferate the growth of spoilage microorganisms. This may warrant addition of acidulates like citric acid to lower the pH to the desired level to may be 3.5-4.0 [21].

Lowering the pH also has an effect on the flavor of the juice and it also improves on the keeping quality of the juice [22]. Blending the pineapple juice with the OFSP which inherently has a high pH could have caused the formulated product to have a relatively high pH. According David *et al.* [21], the pH of orange fleshed sweet potatoes is between 5.9-6.0 and that of pineapples is 3.0-3.1[17]. This can imply that the pineapple might be responsible for the slightly low pH compared to that of the OFSP juice.

3.2.2 Total soluble solids

TSS is widely used to determine the concentration of sugar in products. It is expressed in degrees brix [17]. According to [17], the total soluble solid of the OFSP juice is between 12.57-13.78 ◦ brix and that of pineapple juice is between 11-13◦ brix. The formulated juice has a TSS of 8.0◦ brix and this is slightly lower than the TSS reported from other ready to drink juices. This juice may be good for consumers who are interested in taking less sweet juices and it may not be good for those with a sweet tooth. The TSS of the fruit juice depends on a number of factors like; maturity stage of the fruits, Cultivar, crop size, cultural practices and growing season. They also influence the amount of sugar added to the final product.

3.2.3 Titratable acidity

The titratable acidity measures the organic acid content of the juice drink (McCarthy, 2007). In this study, a TA value of 1.4g/ml was recorded (Table 3). This TA falls in the range of the TA for the pineapple (0.7-1.6g/ml) and that of the OFSP juice (0.36-0.6g/ml) [23]. This is because most of the acid (citric acid) is from the pineapple and not the OFSP juice since it is has a low acid content.

3.2.4. β-carotene and vitamin A content of the OFSP tuber and the most acceptable formulation

Results of β-carotene and vitamin A of the most accepted formulation and the OFSP tuber are indicated in the Table 3

Table 4: Mean values of the Beta-carotene and Vitamin A of the most accepted formulation and the OFSP tuber

	Beta-carotene (µg/100g)	*Vitamin-A (µg/100gRAE)*
Sample (F4)	3713.35 ± 682.01^{b}	309.45 ± 56.83^{c}
OFSP Tuber*	$112120.49 \pm 4461.23^{a}$	9344.08 ± 371.77^{a}

Values with the same super scripts in the same column are not significantly different while those with the different super scripts are significantly different at $p \leq 0.05$.*values of OFSP tuber are expressed on dry matter basis.

The results in Table 4 indicate that there was a significant difference in the β-carotene content of formulation F4 and the OFSP tuber ($p \leq 0.05$). Similarly also there was a significant difference in their vitamin A content on expression as the β-carotene was expressed as vitamin A.

The β-carotene content also expressed as vitamin A was higher in the OFSP tuber compared to the formulation (F4) as shown in the (table 4). This could have been because of dilution with water during processing thus the formulation had a lower β-carotene content. This might have also been caused by the exposure of the OFSP during processing to make the formulation to oxygen during different unit operations like, peeling, cutting, grating and blending because β-carotene is sensitive to heat and oxygen. On fresh weight basis light orange varieties contain at least 250 RAE/100 gm (30 µg/g), medium-intensity varieties at least 458 RAE/100 gm (55 µg/g) and dark-orange -varieties at least 833 RAE/100 gm (100 µg/g) of β-carotene [24]. The recommended dietary allowance (RDA) for vitamin A for infants (0-12months) is between 400-600µg/day, children 4-6yrs is 500µg/day, children 7-10yrs 500-900µg,males (13-≥70yrs) 600-3000µg/day, females (≤19 up to above 70 yrs) 800-3000µg/day and pregnant women (19-above 50 yrs) 750-4000µg/day, lactating women (19-above 50 yrs) 1300-4000µg/day [25]. The formulated juice drink with β-carotene content (3713.35µg/100g) and vitamin A content (309.45 RAE) would meet the vitamin A RDA for most of the age groups thus reducing on VAD.

4. Conclusion

The production and processing of locally available agricultural produce plays a very crucial role in income generation, nutrition status, employment opportunity and improvement of nutrition and socio-economic status of the rural poor who are the majority of the population in Uganda. The OFSP based juice drink is one of the several value added products that can be produced from the locally grown food crops and fruits.

The development of an acceptable OFSP based juice drink was possible and successfully done. It was possible to formulate an acceptable OFSP based juice drink made up of locally available pineapples and OFSP (OFSP as the major component). Physico-chemically the most acceptable juice drink formulation (F4) had a pH (4.90) which may compromise its keeping quality. The juice drink also had substantial quantities of vitamin A (309.45±56.83) thus the juice drink can be used to combat VAD

5. Future Scope

Further research on the shelf life and microbiological stability of the juice drink is recommended. Due to the high pH (4.90) of the juice drink, it is recommended that acidulants should be added to lower the pH in order to improve on the juice drink's stability during storage.

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