

# Sour Apple Concentrate: processing essentials and organoleptic properties

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**Abstract**—The aim of this study is to have a new apple-based product with relatively long shelf life. Sans Pareille, *Malus domestica*, 'mouwachah' was harvested prematurely and sour-apple-concentrate was produced following a traditional Lebanese recipe used to produce pomegranate sauce (PS). Part of the prepared SAC had Salt added (SACSa), another citric acid (SACCA) and both Salt and Citric Acid (SACSaCA). The higher the Brix the significantly higher the density and total caloric content and significantly lower water-activity. There was no significant difference in caloric value on Dry-Matter basis. Furthermore, SAC and SACSa had significantly lower pH only at 75°Brix. Within SACCA and SACSaCA pH at the 75°Brix is significantly the lowest compared to pH values at 55 and 65°Brix. The higher the Brix-level the significantly higher the Titratable Acidity (TA) in all products except in SACSaCA where it was significantly higher only at 75°Brix. Within the same Brix level, TA of SAC and SACSa did not differ significantly, while TA was significantly lower than TA of SACCA and SACSaCA. These products were compared to traditional products PS and grape-verjuice. In terms of aroma, appearance, texture, taste, sourness, sweetness, overall-acceptability and average score of the Sour Apple concentrate products, except for SACSaCA, scored significantly higher than PS and grape verjuice. Within the Sour-Apple-Products the 75°Brix score significantly the lowest. These results showed that Sour apple concentrate with 65°Brix with addition of salt or citric acid but not both.

**Keywords**—Apple, Sans Pareille, Apple juice, Sour Apple Concentrate, mouwashah, Citric Acid, Salt, water activity.

## I. INTRODUCTION

Lebanese "traditional" varieties of apples mainly Red Delicious, Golden Delicious and Sans Pareille (mouwachah) apple, are planted and relatively newer varieties have been introduced such as Gala, Fuji, Scarlett, Super Chief, and Granny Smith. All of these apples had little access to the regional market in last few years due to the regional situation. FAO stats 2013 states that the total Area planted with apples is of 13,604 hectares (ha) producing of 153,151 tons of apples annually constituting 23% of total Lebanese fruits production [1].

Apple juice has pleasant taste and high concentration of phenolic compounds, vitamins, minerals, dietary fiber and antioxidant capacity [2-4]. Some intrinsic and extrinsic factors affect the properties of Fruit-based products that are assessed by different chemical, physical, and sensory parameters. Intrinsic factors include maturity, cultivar, root-stock and pest resistance. Extrinsic factors include growing region, cultivation practices, climate, water stress, storage conditions and the processing technology, packing and transportation [5]. Industrial products from apples include: apple juice, dried apples, apple vinegar and sweet apple molasses [6].

Sans Pareil is woody perennial and Deciduous Fruit. It is an old apple variety which can be eaten fresh or used for cooking. It blooms in March and is harvested in September. This variety is very sweet and juicy is has a large fruit with orange and yellow skin. It is also one of the highly susceptible varieties to fire-blight. This in addition to the problem of marketing all Lebanese apples made this variety suitable to study its development into a shelf stable product resembling two traditional products in the Lebanese market, mainly grape-verjuice and pomegranate sauce. Noting in fruits the harvest time affected pH, organic acids, sugars, taste, but not aroma [7].

The grape-verjuice is simply the juice of unripe grapes, which is boiled and bottled with a 13°Brix total soluble solid. The low pH (2.6-2.9) and the optional addition of salt makes this product shelf stable grape-verjuice. As for the pomegranate molasses it is done from pomegranate juice which is thickened by boiling to reach around 65-73°Brix of total soluble solids and a pH value ranging from 1.73 to 3 [8]. Unripe apple juice made from apples harvested in July/august was studied and compared to those sauces mentioned above.

Unripe Sour apple concentrate might be a food ingredient that provides acidity and flavor and as an alternative to

vinegar in salad dressings and other applications where the sensory character of acetic acid is unacceptable [9]. Because it can be produced from unripe apple with fire-blight, it might be of great interest to apple growers and to the food industry.

## II. MATERIALS AND METHODS

### 2.1. Sour apple concentrate preparation

The materials used in this study are unripe Sans Pareille, *Malus domestica*, (mouwachah) which were collected in end of July, washed and pressed to produce Sour Apple juice of 13°Brix total soluble solids. This juice was thickened by boiling to have Sour Apple Juice, Sour Apple Concentrate plus salt (1%), Sour apple concentrate plus citric acid (1%) and Sour apple concentrate plus both salt and citric acid all with 55, 65 and 75°Brix total soluble solids (Fig. 1).

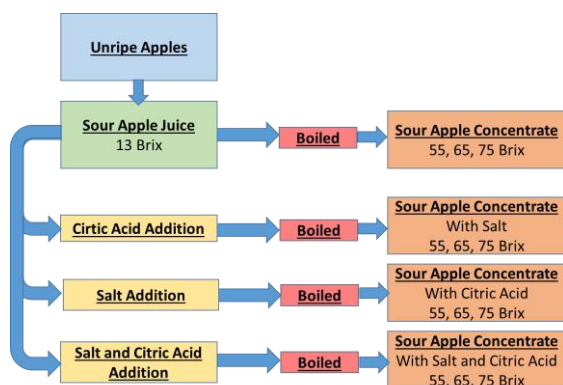


Fig.1: Sour Apple Concentrate production flow

#### 2.1.1. Sour Apple Juice, Grape-Verjuice and Pomegranate sauce

Homemade verjuice and pomegranate concentrate were collected and the physico-chemical properties were recorded.

### 2.2. Equipment used to measure Physico-chemical properties

**Brix Value:** Brix Value was measured using Portable hand held RFM700 refractometer (Bellingham and Stanley LTD. United Kingdom).

**Weight determination:** Weight was measured using Portable electronic balance Model 727 was used to measure the weight with an accuracy of  $\pm 1$  gr (Jata Hogar).

**pH:** Microcomputer based pH /conductivity /TDS /salinity and temperature pocket meter Model pH/EC80 was used to measure the pH (Jenco VisionP).

**Ash content:** Ash was determined using the AOAC 942.05 method.

**Volume Determination:** 10mL glass graduated cylinder, with sub gradations of 0.1mL (Graduated cylinder, tall form, BLAUBRAND®, class A, Boro 3.3, DE-M).

**Caloric Value:** Bomb calorimeter IKA C200 was used (KA®-Werke GmbH & Co. KG)

### 2.3. Sensory Analysis

The sensory attributes attained from 35 taste panelists repeated 3 times include: aroma with 1 having no aroma and 9 having best aroma, appearance with 1 having worst appearance and 9 having the best appearance, texture with 1 being the worst and 9 being the best one, sourness with 1 having no sourness and 9 having the highest sourness, sweetness with 1 having no sweetness and 9 having highest sweetness and overall acceptability with 1 having lowest acceptability and 9 having the highest acceptability. In addition to that, the sensory score of each Sour apple concentrate was calculated by taking the mean of the different sensory attributes.

### 2.4. Statistical analysis

All tests and analysis were run in triplicates and averaged. General linear model performed via SPSS (statistical Package for the Social Sciences, version 17.0) was used to study the difference between Sour Apple Juice products in terms of density, caloric content on product basis and on dry matter basis, ash content, pH, titratable acidity (gr/100ml) and total soluble solids per titratable acidity among and within the different Brix.

Furthermore, General linear model performed via SPSS was used to assess the difference between the Sour apple concentrate products, with and without salt, with and without citric acid and with both salt and citric acid taking Brix as a covariate.

To study the effect of Brix on the average score General linear model performed via SPSS was used taking salt and citric acid addition as covariate.

## III. RESULTS

### 3.1 Sour Apple Juice, verjuice, pomegranate

The Juice extracted from the unripe apples had a brix value of 13°Brix which comparable to that of verjuice but much lower than that of pomegranate (Table 1). They did differ significantly in terms of pH where Verjuice showed the lowest and consequently the highest TA and the lowest TSS/TA.

Concerning the juice to concentrate conversion value it was noted that 100gr of premature apple was needed to produce 61.3gr Apple Juice with 13°Brix., 14.5gr SAC with 55°Brix, 12.25gr SAC with 65°Brix and 10.63gr SAC with 75°Brix.

Table.1 Sour unripe Apple Juice, Verjuice and pomgranate

## Physical properties

	Apple juice	Verjuice	Pomegranate
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
TSS (Brix)	13.0 $\pm$ 0.002	13.1 $\pm$ 0.002	65.0 $\pm$ 0.002
pH	3.67 $\pm$ 0.04	2.84 $\pm$ 0.04	4.04 $\pm$ 0.04
TA (gr/100ml)	4.53 $\pm$ 0.96	17.73 $\pm$ 1.00	10.47 $\pm$ 0.95
TSS/TA	2.87 $\pm$ 0.031	0.73 $\pm$ 0.03	6.21 $\pm$ 0.03

TSS: Total Soluble Solids; TA: Titratable Acidity;

Among rows means with different letters are significantly different

## 3.2 Physicochemical properties

## 3.2.1 Density

Comparing the density of the different Sour Apple Concentrate (SAC) [10] products within the same brix, showed that the density of the SAC within 55°Brix was significantly the lowest while there was no difference when comparing densities of SAC with Salt addition (SACSa), SAC with citric acid addition (SACCA), SAC with Sa and CA addition (SACSaCA). This difference, however, difference disappeared within 65 and 75°Brixes (Table 2).

Table.2: Density of different sour apple concentrate products

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	1.257 <sup>a</sup> $\pm$ 0.002	1.320 <sup>b</sup> $\pm$ 0.002	1.362 <sup>c</sup> $\pm$ 0.002
SACSa	1.264 <sup>a2</sup> $\pm$ 0.002	1.319 <sup>b</sup> $\pm$ 0.002	1.359 <sup>c</sup> $\pm$ 0.002
SACCA	1.264 <sup>a2</sup> $\pm$ 0.002	1.310 <sup>b2</sup> $\pm$ 0.002	1.361 <sup>c</sup> $\pm$ 0.002
SACSaCA	1.270 <sup>a2</sup> $\pm$ 0.002	1.323 <sup>b</sup> $\pm$ 0.002	1.363 <sup>c</sup> $\pm$ 0.002

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

Within the same product the density of SAC, SACSa and SACA as expected was significantly higher the higher the brix value. The density of SACSaCA was significantly the highest at 75°Brix, this significance did not show between the 55 and 65°Brix (Table 2).

## 3.2.2 Caloric content product basis and dry matter basis

The total caloric content within the product type is as expected where the higher the brix value the significantly higher the caloric content. (Table 3). Furthermore, within the same Brix, 55, 65 and 75, there was no significant difference in the caloric value (Calorie/100gr Product) between SAC, SACSa, SACCA and SACSaCA

Table.3: Caloric content of different sour apple concentrate products per 100 gr product

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	172.13 <sup>a</sup> $\pm$ 2.75	207.84 <sup>b</sup> $\pm$ 2.75	233.72 <sup>c</sup> $\pm$ 2.75
SACSa	177.06 <sup>a</sup> $\pm$ 2.75	206.04 <sup>b</sup> $\pm$ 2.75	237.27 <sup>c</sup> $\pm$ 2.75
SACCA	174.36 <sup>a</sup> $\pm$ 2.75	206.37 <sup>b</sup> $\pm$ 2.75	233.40 <sup>c</sup> $\pm$ 2.75
SACSaCA	176.75 <sup>a</sup> $\pm$ 2.75	207.10 <sup>b</sup> $\pm$ 2.75	234.77 <sup>c</sup> $\pm$ 2.75

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

The caloric content per dry matter within SAC, SACSa, SACCA and SACSaCA among the different brixes did not differ significantly. The same is true concerning the caloric content of the different SAC products, with and without salt and citric acid, where it did not differ significantly (Table 4).

Table.4 Caloric content of different sour apple concentrate products per 1 gr Dry Matter

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	3.107 <sup>a</sup> $\pm$ 0.044	3.163 <sup>a</sup> $\pm$ 0.041	3.127 <sup>a</sup> $\pm$ 0.04
SACSa	3.144 <sup>a</sup> $\pm$ 0.044	3.136 <sup>a</sup> $\pm$ 0.041	3.176 <sup>a</sup> $\pm$ 0.04
SACCA	3.092 <sup>a</sup> $\pm$ 0.045	3.185 <sup>a</sup> $\pm$ 0.041	3.120 <sup>a</sup> $\pm$ 0.04
SACSaCA	3.134 <sup>a</sup> $\pm$ 0.046	3.134 <sup>a</sup> $\pm$ 0.058	3.140 <sup>a</sup> $\pm$ 0.04

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

## 3.2.3 Water Activity

As expected the higher the brix value the significantly lower the water activity within the different SAC products (Table 5).

Table.5 Water activity of the different SAC products

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	0.976 <sup>a</sup> $\pm$ 0.116	0.84 <sup>b</sup> $\pm$ 0.046	0.715 <sup>c</sup> $\pm$ 0.047
SACSa	0.97 <sup>a</sup> $\pm$ 0.112	0.809 <sup>b2</sup> $\pm$ 0.046	0.701 <sup>c</sup> $\pm$ 0.044
SACCA	0.971 <sup>a</sup> $\pm$ 0.133	0.868 <sup>b3</sup> $\pm$ 0.046	0.714 <sup>c</sup> $\pm$ 0.045
SACSaCA	0.97 <sup>a</sup> $\pm$ 0.135	0.795 <sup>b2</sup> $\pm$ 0.044	0.671 <sup>c2</sup> $\pm$ 0.044

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

Within the 55°Brix the water activity did not differ significantly between the water activity values of SAC, SACSa, SACCA and SACSaCA. Within 75°Brix the water activity value of SACSaCA was significantly the lowest with the difference in water activity values of SAC, SACSa and SACCA was not significant (Table 5).

### 3.2.4 Ash content

As for the Ash-content within SAC showed no significant difference among the different Brixes. Within SACSa and SACCA the ash content at 55 and 65°Brix did not show any significant difference both being significantly lower than the ash content at 75°Brix. Within SACSaCA the ash content at 55°Brix was significantly lower from those 65 and 75°Brix whose ash content did not differ significantly from each other (Table 6).

Table.6 Ash content per product (gr/gr)

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	0.004 <sup>a</sup> $\pm$ 0.002	0.005 <sup>a</sup> $\pm$ 0.001	0.006 <sup>a</sup> $\pm$ 0.04
SACSa	0.011 <sup>a</sup> $\pm$ 0.002	0.014 <sup>a</sup> $\pm$ 0.001	0.016 <sup>b</sup> $\pm$ 0.04
SACCA	0.011 <sup>a</sup> $\pm$ 0.002	0.014 <sup>a</sup> $\pm$ 0.001	0.016 <sup>b</sup> $\pm$ 0.04
SACSaCA	0.020 <sup>a</sup> $\pm$ 0.002	0.025 <sup>b</sup> $\pm$ 0.002	0.028 <sup>b</sup> $\pm$ 0.04

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

### 3.2.5 pH

The pH within the SAC and SACSa showed no significant difference between 55 and 65°Brix with pH at 75°Brix being significantly the lowest (Table 7).

Within 55°Brix, the pH of SAC was significantly the highest compared to pH of SACSa and SACCA, which did not differ significantly from each other. The pH of SACSaCA was significantly the lowest (Table 7).

Table.7 pH of the different Sour apple concentrate

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	3.069 <sup>a</sup> $\pm$ 0.04	2.983 <sup>a</sup> $\pm$ 0.038	1.877 <sup>b</sup> $\pm$ 0.037
SACSa	2.942 <sup>a</sup> $\pm$ 0.04	2.840 <sup>a</sup> $\pm$ 0.037	1.923 <sup>b</sup> $\pm$ 0.037
SACCA	2.870 <sup>a</sup> $\pm$ 0.041	2.727 <sup>b</sup> $\pm$ 0.037	1.780 <sup>c</sup> $\pm$ 0.037
SACSaCA	2.760 <sup>a</sup> $\pm$ 0.042	2.592 <sup>b</sup> $\pm$ 0.053	1.930 <sup>c</sup> $\pm$ 0.037

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

Within 65°Brix the pH of all SAC products differ significantly from each other with SAC being significantly the highest, followed by the pH of SACSa and by the pH of SACCA and SACSaCA being significantly the lowest (Table 7).

Within the 75°Brix the pH of SAC, SACSa, SACCA and SACSaCA did not differ significantly from each other (Table 7).

### 3.2.6 Titratable Acidity and Total Soluble Solids per Titratable acidity

Titratable Acidity within the SAC products showed that the higher the Brix the significantly higher the Titratable Acidity (Table 8).

Within the same Brix the SACCA had the significantly highest Titratable Acidity, followed by the Titratable Acidity of the SACSaCA which is significantly higher than the SACSa and SAC which were significantly the lowest (Table 8).

Table.8 Titratable Acidity (gr/100ml) of the different Sour Apple products

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	37.18 <sup>a</sup> $\pm$ 1.06	40.69 <sup>b</sup> $\pm$ 0.97	49.43 <sup>c</sup> $\pm$ 0.96
SACSa	35.77 <sup>a</sup> $\pm$ 1.05	43.35 <sup>b</sup> $\pm$ 0.98	49.40 <sup>c</sup> $\pm$ 0.96
SACCA	50.49 <sup>a</sup> $\pm$ 1.08	62.75 <sup>b</sup> $\pm$ 0.98	95.19 <sup>c</sup> $\pm$ 0.96
SACSaCA	46.47 <sup>a</sup> $\pm$ 1.09	47.57 <sup>a</sup> $\pm$ 1.39	53.65 <sup>b</sup> $\pm$ 0.96

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

Among Columns: means with different numbers are significantly different

Within SAC and SACSa the brix had no clear significant effect on the Total Soluble Solids per Titratable Acidity (TSS/TA). Within SACCA where the TSS/TA at 55 and 65°Brix were significantly higher than TSS/TA at 75°Brix. Within SACSaCA the TSS/TA at 55°Brix was significantly the lowest where the TSS/TA at 65 and 75°Brix did not differ significantly (Table 9).

Table.9 Total Soluble Solids (Brix) per Titratable Acidity (gr/100ml) of the different Sour Apple products

Brix	55	65	75
	Mean $\pm$ SE	Mean $\pm$ SE	Mean $\pm$ SE
SAC	1.495 <sup>a</sup> $\pm$ 0.031	1.613 <sup>b</sup> $\pm$ 0.031	1.512 <sup>a</sup> $\pm$ 0.031
SACSa	1.583 <sup>a</sup> $\pm$ 0.031	1.515 <sup>a</sup> $\pm$ 0.031	1.513 <sup>a</sup> $\pm$ 0.031
SACCA	1.119 <sup>a</sup> $\pm$ 0.031	1.032 <sup>a</sup> $\pm$ 0.031	0.787 <sup>b</sup> $\pm$ 0.031
SACSaCA	1.217 <sup>a</sup> $\pm$ 0.031	1.391 <sup>b</sup> $\pm$ 0.031	1.394 <sup>b</sup> $\pm$ 0.031

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid;

Among rows: means with different letters are significantly different;

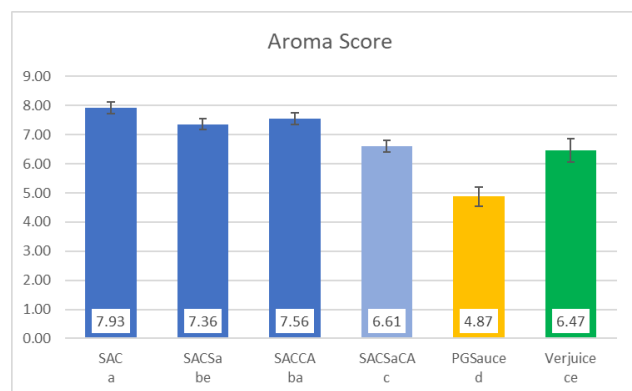
Among Columns: means with different numbers are significantly different

Within the same Brix the SACCA had the significantly lowest TSS/TA, followed by the Titratable Acidity of the SACSaCA which is significantly lower than the SACSa and SAC which were significantly the highest (Table 9).

## 3.3 Sensory Attributes

### 3.3.1 Aroma

The aroma score of pomegranate concentrate was significantly the lowest followed by verjuice and SACSaCA which did not differ significantly. Furthermore, verjuice did not differ significantly from SACSa, SAC and SACSa possessed the highest aroma scores (Fig.2).

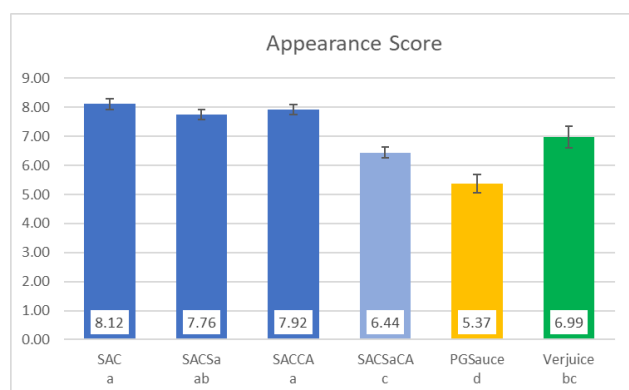


**Fig.2 Aroma Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate;  
Product means with different letters are significantly different

### 3.3.2 Appearance

The pomegranate concentrate score significantly the lowest score in terms of appearance followed by SACSaCA and Verjuice with SAC, SACCA and SACSa being the highest (Fig. 3).

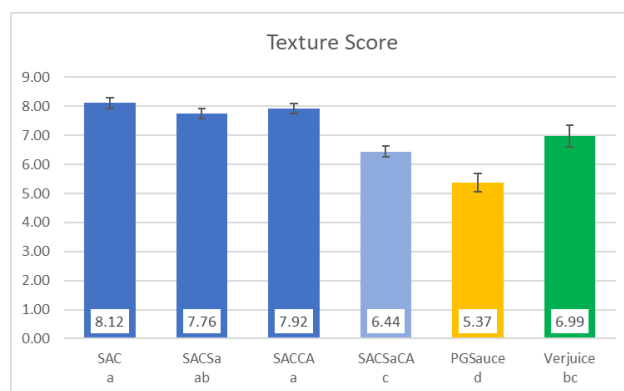


**Fig.3 Appearance Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate;  
Product means with different letters are significantly different

### 3.3.3 Texture

The Texture score of pomegranate is significantly the lowest followed by SACSaCA and Verjuice with SAC, SACCA and SACSa being the highest (Fig. 4).

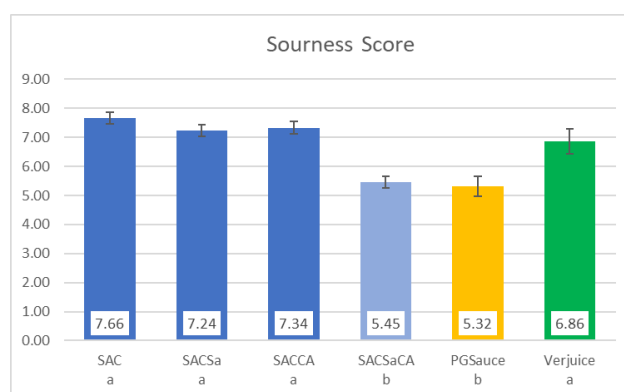


**Fig.4 Texture Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate;  
Product means with different letters are significantly different

### 3.3.4 Sourness

The score of sourness was significantly the lowest for pomegranate sauce and SACSaCA followed by the verjuice which did not differ significantly from SAC, SACSa and SACCA which tended to have the highest score (Fig. 5).

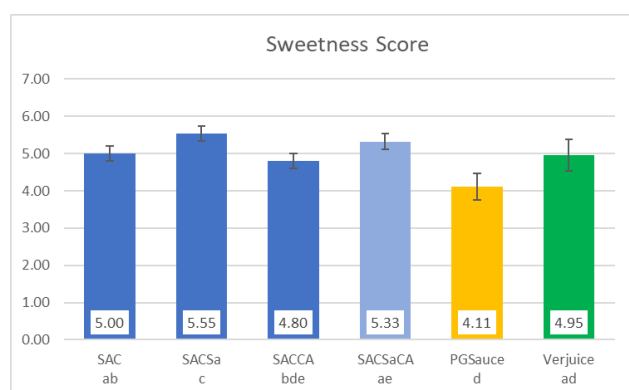


**Fig.5 Sourness Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate;  
Product means with different letters are significantly different

### 3.3.5 Sweetness

The pomegranate have the significantly lowest score although it did not differ significantly from the verjuice. The SACSa sweetness score had the significantly highest score. The SACSaCA, SAC and SACA score were in between and in descending order (Fig. 6).

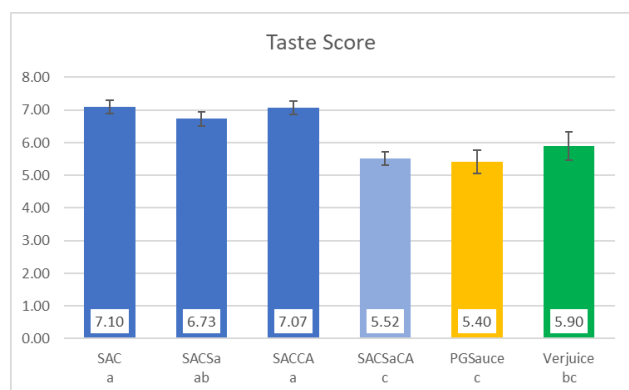


**Fig.6 Sweetness Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate; Product means with different letters are significantly different

### 3.3.6 Taste

The taste scores of the pomegranate followed by SACSaCA are significantly lower than SACSa, SACCA and SAC possessing the highest score. Concerning grape verjuice is not significantly different from pomegranate, SACSaCA and SACSa (Fig. 7).

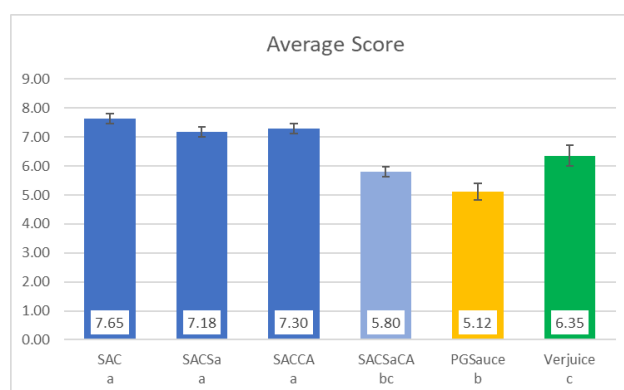


**Fig.7 Taste Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate; Product means with different letters are significantly different

### 3.3.7 Average Score

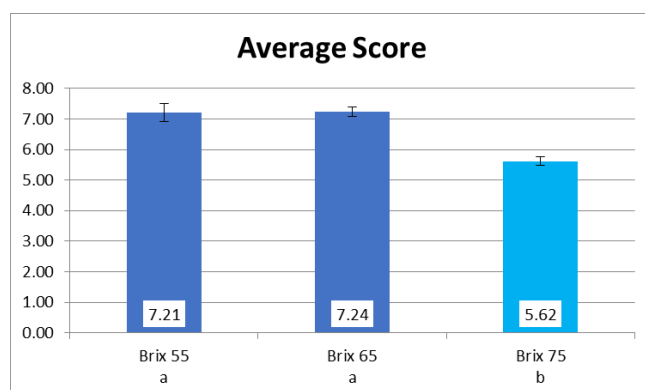
The average scores of the pomegranate is significantly lower than all SAC products and verjuice and not from SACSaCA. There is no significant difference between the average scores of SAC, SACSa and SACCA and all are significantly than the SACSaCA, pomegranate and grape verjuice (Fig. 8).



**Fig.8 Average Score of different Sour Apple concentrate products, pomegranate sauce and verjuice**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate; Product means with different letters are significantly different

There was no significant difference of the sour apple concentrate of 55 and 65°Brix. The average score of the sour apple concentrate of 75°Brix scored significantly the lowest (Fig. 9).



**Fig.9 Average Score of different Sour Apple concentrate Brix**

SAC: Sour Apple Concentrate, Sa: Salt, CA: Citric Acid; PG: Pomegranate; Product means with different letters are significantly different

## IV. DISCUSSION

The level of efficiency is calculated by the gr of juice per 100 gr of apples. As for the character of the sour apple juice in terms of pH which is lower than 4.2 thus starting as a high acid food and the higher the brix the lower the pH. This was reflected in titratable acidity which is higher the higher the Brix and with citric acid addition the much higher the titratable acidity. Furthermore, the ripening index [11] of apples, total soluble solids (Brix) per titratable acidity (gr/100ml) for this study was recorded and sets a benchmark for future studies.

As for the density of sour apple concentrate, it is an important factor to calculate the weight and size of bottle in terms one portion. In addition to that based on this one can study the efficiency of transportation. Taking into

consideration the higher the Brix, the higher the density. The caloric content as expected was higher with increasing brix. This is an important information since the new trend in the 21<sup>st</sup> century is wellness.

Concerning the water activity it is a tool to know the type of the product and to be the basis for future shelf life studies in combination with the pH, titratable acidity and Total Soluble Solids per Titratable Acidity.

After setting the physicochemical properties, the sensory analysis study the perception of people for the apple based new product namely the Sour Apple concentrate in comparison with two traditional products: pomegranate and grape verjuice.

The aroma of the verjuice is scored higher than that of pomegranate which might be due to processing method. The verjuice might be boiled but that of pomegranate it is not only boiled but condensed through evaporation [12]. The aroma of the condensed sour apple concentrate scored higher than pomegranate sauce although it possessed similar production method [13]. This is true in all the other sensory attributes except for the sweetness where those having salt addition, including verjuice [14], had higher scores than those without. This might be because a pinch of salt would increase the sweetness perception. The average score showed that the sour apple concentrate products except the one with both citric acid and salt was significantly higher than the pomegranate sauce and verjuice. In addition to that, the average score of 75°Brix was lowest thus 65°Brix should be considered as the highest concentration.

## V. CONCLUSION

The sour apple concentrate 75°Brix showed lower pH and water activity, but in terms of sensory score, the 55 and 65°Brix scored higher thus should be considered. Unripe apple juice made from apples harvested in July/august can be used to produce Sour apple concentrate a food ingredient that provides acidity and flavor and as an alternative to verjuice and pomegranate sauce in salad dressings and other applications where it scored higher than both [15]. Citric acid addition or salt addition can be used to add some protection to the product. But it is not advised to use both salt and citric acid together. This is a product of interest to apple growers and to the food industry since it increase the potential of having a product with relatively long shelf.

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