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# DETERMINATIONS OF PHYSICAL AND CHEMICAL PROPERTIES OF KWAZULU-NATAL'S HOUSEHOLD WHITE PEACH 'LANDRACE' IN RELATION TO EXTENSION SERVICES - A CASE STUDY OF IMPENDLE LOCAL MUNICIPALITY

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## *ABSTRACT*

*Indigenous fruits constitute a very important part in the food basket of the household farming community in South Africa. Household growers of white peach landrace in KwaZulu-Natal at Impendle Local Municipality suffer major losses due to lack of maturity indices that would allow them to predict and plan for harvesting dates. As a result, the fruit is harvested later than its physiologically correct date and processing becomes difficult when the fruit is overripe or spoilt. Extension services do not have enough information on such fruit quality parameters to assist the farmers. With the aim of developing and promoting the value chain in household farming, this study identified physical and chemical parameters linked to peach landrace maturity in relation to extension. Maturity and ripening related parameters were determined. Fruit reached maturity 129 days after full bloom (DAFB) and this coincided with mass, volume and moisture content at respective stages of 80.00 g, 55.20 cm$^3$, and 83%. Firmness decreased significantly from 79.00 N to 24.70 N during ripening. Total soluble solids (TSS) increased from 13.5 to 19.00 °Brix. The pH value decreased from 3.40 to 4.00. The TSS:TA (titrable acidity-TA) ratio increased from 21.11 to 35.84. The results showed that DAFB, firmness, mass, TSS, volume, and TSS:TA ratio have potential to be used in relation to extension for maturity indexing of white landrace peach fruit as parameters to determine the maturity indices and quality of the smallholder farmer.*

**Keywords:** Extension services, Local informal market, Degree of ripeness, Postharvest quality, Maturity

## 1. INTRODUCTION

A robust triangular connection between a household farmer and extension, research and extension, and farmer and researcher ensure a smooth transition in research technology transfer and adoption to the household farming community. Small-scale fruit producers, unlike the commercial farms, lack the simplest means to identify the maturity of many different fruit types in South Africa. Amongst the fruit produced, the peach fruit grown by small-scale growers in KwaZulu-Natal is not an exception. The methods used in the commercial sector are complex and unaffordable to the small-scale growers and as a result not adopted. No study results are available for extension services to refer to when advising smallholder farmers on maturity indices and this subsequently makes it difficult for the

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extension officer to advise household farmers with interest to supply fresh and processed peaches to local informal markets. Such information is very important when handling highly perishable fresh produce such as peach fruits. It enables the farmers to decide when to expect first harvest and be able to plan for the entire process of processing or supplying the markets. Peach (*Prunus persica* (L.) Batsch) growth, development and ripening are continuous critical processes that involve a complex series of biochemical and molecular changes that take place in four categorical steps (Lombardo, Osorio, Borsani, Lauxmann & Bustamante, 2011). The first exponential stage is characterised by rapid cell division, growth and elongation, and is known as S1. During the second stage, the endocarp (inner core) hardens to form the stone and during this stage size does not increase and the stage is known as S2.

During the third stage, the second exponential phase takes place and is characterised by an increase in fruit size and cell division, and this stage is described as S3. The final stage, S4, is subdivided into S4-1 and S4-2 stages. During S4-1, the fruit reaches the final size and during S4-2 stage, the fruit enters into a ripening process which is ethylene dependent, also described as the climacteric stage where the fruit also continues to ripen when detached from the tree (Trainoti, Tadiello & Casadoro, 2007; Borsani *et al*., 2009; Dardick, Callahan, Chiozzotto, Scaffer, Piagnani & Scorza, 2010). Peach ripening is a complex process with many physiological and biochemical changes such as starch and chlorophyll degradation, biosynthesis of volatile compounds and pigments, accumulation of sugars and acids, as well as modification of cell walls, all occurring concurrently (Prinsi, Negri, Fedeli, Morgutti, Negrini, Cocucci & Espen, 2011). Physiological maturity is the development stage when a plant continues ontogeny even if picked from the tree (Kader, 1999). Therefore, the ripening of peaches cannot be determined by a single parameter (Shinya, Contadoe, Frett & Infante, 2014). Peaches have a very short shelf-life as a result of a rapid ripening process. This results in a limited period for postharvest handling (Cano-Salazar, Lopez & Echeverria, 2013). In order to harvest the peach at the correct period and handle it properly, it is necessary to understand fruit maturity, ripeness and postharvest quality parameters since they are interrelated, and they need to be considered together. Fruits and vegetables can be harvested at either physiological or horticultural maturity, depending on the intended use of produce.

Horticultural maturity is defined as a stage of growth when a plant possesses the primary attribute for utilisation by consumers or processors for special purposes (Kader, 1999; Wills, McGlasson, Graham & Joyce, 2013). Peach fruit has different stages of maturity depending on its intended use (Wills *et al.,* 2013). These are hard (suitable for long distance export markets), firm (suitable for long distance export and domestic markets), firm-ripe (suitable for short distance export market), tree-ripe (suitable for short distance local market) and soft-ripe (suitable for ready consumption and processing purposes) (Teakey & Shoemaker, 1972). The maturity standards vary according to variety as well as the environmental conditions during fruit production and postharvest handling (Badiyala & Awasthi, 1990).

Maturity indices are determined by sensory methods (flavour, colour, aroma, texture), adequate postharvest shelf life, scheduled picking and packing operations, and proper marketing (Dhatt & Mahajan, 2007). A clear understanding of maturity is critically important and interconnected with the ripening process. Fruit ripening is greatly influenced by the physiological maturity of the fruit at harvest (Ferrer, Remoń, Negueruela & Oria, 2005). Fruit harvested at an immature stage are susceptible to shrinkage, whereas fruit harvested at an over-mature stage are likely to be soft and to perish faster than usual (Ferrer *et al*., 2005). One of the challenges in the peach industry is the segregation of fruit with different ripening stages during picking because of a long period of flowering (Shinya, Contandor, Predieri, Rubio & Infante, 2013). Many different maturity indices such as flesh colour, firmness, background colour (Kader, 1999; Crisosto & Valero, 2008; Infante, 2012; Slaughter, Crisosto & Tiwari, 2013), texture (Prinsi *et al.*, 2011), ground skin colour (Sinya *et al.*, 2013), total soluble solids (TSS), titrable acidity (TA), TSS:TA ratio, and mass change (Ferrer *et al*., 2005) have been used to determine peach ripeness. These indices, however, vary between cultivars and must be developed for each cultivar. Although much of this information is available for many commercial peach varieties, there are no records available for the Impendle peach landrace grown by small-scale farmers in KwaZulu-Natal, South Africa.

Impendle peach households rely very much on the fruit for vitamin A and other nutritional properties. However, productivity and quality remain an issue with major postharvest losses due to lack of practical indices for determining fruit quality, maturity and ripeness, and a limited understanding of protocols for postharvest handling. The harvest period is from late December to mid-March, and during this period, close to 50% of the harvested fruit goes to waste as a result of improper harvesting and handling. Research into peach landraces growth, effective cultivation practices, as well as harvest and postharvest technology can develop appropriate technologies. Therefore, the aim of this study was to evaluate the physical and chemical properties related to maturity and ripening to be used as harvesting indices for indigenous white flesh clingstone peach landrace produced by household farmers at Impendle. The expected outcomes of the study are that results will be applicable in improving the value chain of the household farmers with assistance by the farmer-extension-research linkage.

## 2. MATERIALS AND METHODS

### 2.1 Site description

The site was located at a small-scale peach farming community in Impendle, South Africa (29°37’04.09”S; 29°51’23.8”E). The area is located at an elevation of 1420 m above sea level, with annual average temperatures ranging between 12 and 16 °C, characterised by 800 – 900 annual average chilling units (CU) (Camp, 1999). The soil type is acidic, red-yellow freely drained apedal (Camp, 1999). The peach crop depends on rainfall which ranges between 1000 and 1100 mm per annum. No irrigation, pruning, fertilizer or pesticide treatments are used to improve tree productivity. Farmers use cow manure only at seedling transplanting. The trees are planted in one row per homestead, with intra row spacing of 4-6 m. Generally, homesteads have one to 40 trees, depending on the family size and period spent as residents in the area. The trees used in the study ranged between 8 to 12 years old. Branches and leaves are at 1.5 m above the ground and trees grow to 3.5 m tall.

### 2.2 Plant material

The experiments were carried out during the 2014/15 harvesting season. Homesteads were selected from the location with the highest number of chilling units determined by method of Camp (1999). Three homesteads were selected, and five trees marked per homestead and fruit was harvested and graded with each homestead treated as a replicate. No homestead with less than 10 trees was selected. Furthermore, 300 fruits were tagged at full bloom and days to maturity from full bloom recorded. Fruit were harvested from three homesteads on five marked trees per homestead. The fruit was harvested manually, bulked randomly, packed in cooled boxes, transported to the laboratory, and sorted by size using vernier callipers and into five different colours using the calorimeter classification of AOAC (1990) standards as mature-green (1); pale-green (2); whitish (3); pale-white (4); and white (5). Large and small fruit were discarded, and only medium sized fruit were used in the study in order to reduce variation.

After sorting and grading, fruit were pre-cooled to 5 °C and stored at 90% relative humidity (RH) for 24 h. Peaches were then removed from the cold room and allowed to reach the room temperature of 20 °C. Five fruit from each degree of ripeness were assessed for mass, colour, firmness, size, moisture content, TSS, pH, and TA. Measurements were carried out in a controlled laboratory condition at 20 °C.

**2.3 Physical quality analysis**
2.3.1 Fruit mass

Individual fruit mass was determined at each degree of ripeness by objectively and non-destructively measuring the mass using a balance scale (Model: Mettler PJ 300, Switzerland) with a ± 0.0001 g accuracy.

2.3.2 Fruit colour

Colour was determined using a Hunter Lab Colour Flex EZ Spectrophotometer (Model: 45/0 LAV, Reston, VA, USA) that measured the CIE L*, a* and b* of the peach fruit colour attributes (Pathare, Opara & Al-Said, 2013). The instrument was calibrated each day using a standard white tile that had the following readings: L* = 94.0, a*=1.1, b* = 0.6.

2.3.3 Fruit firmness

The fruit firmness was determined destructively, using a 7.9 mm probe moving at a 60 mm per minute speed and a penetrating depth of 8 mm into the flesh, after the skin was removed by scalpel before measuring (Chen & Opara, 2013). The Instron Universal Testing Machine (Model: 3345, by HIS Engineering 360, USA) was used to measure peach firmness. Five fruits of each degree of ripeness were selected and measured for firmness. Two opposite sides on the equatorial face of each fruit were punctured and a total of 10 readings were recorded per degree of ripeness. The penetration force results were expressed in Newton's (N).

2.3.4 Fruit volume

Fruit dimensions were measured by determining two readings with the longitudinal dimension (L) referred to as the length and the average of two readings measured perpendicular to the length as the diameter (D). A vernier calliper (Mitutoyo, Kawasaki, Japan) with a precision of ± 0.01 mm was used to measure fruit dimensions. Five fruits replicated three times were selected from each degree of ripeness and average L and D were determined for each degree of ripeness. The fruit volume could then be calculated using equation (1) (Al-Yahyai, Al-Said & Opara, 2009).

Fruit volume (V) = $4^{-3} x \pi x r^3$
(1)
Where r is the average of the fruit radius of the fruit diameter and length sections (cm).

2.3.5 Fruit dry matter content

Dry matter content was measured from five selected fruit samples per degree of ripeness. A 10 g sample of the sliced 2 mm thick peaches was dried in the oven for six hours at 70 °C and thereafter, mass was determined in every 2 hours until a constant mass was reached. Dry matter was calculated (Chen, Wall, Paull & Follett, 2009).

**2.4 Chemical quality analysis**

2.4.1 Total soluble solids

The measurement of total soluble solids was carried out using a thermo-compensated refractometer (Atago, Model PR-1, Tokyo, Japan) with a precision of ± 0.1% °Brix (Magwaza *et al*., 2013). Peach juice was extracted using a household blender that was used to slice the fruit into smaller pieces. A muslin cloth was used to squeeze juice into a 50 ml glass beaker which was then extracted for analysis using a 5 ml pipette. Two drops of the juice were placed on the refractometer prism and readings were recorded. This process was replicated three times per fruit sample and ethanol was used to clean the prism after each measurement.

2.4.2 Fruit pH and titrable acidity

The measurement of peach fruit pH was carried out using a laboratory bench top digital pH-meter (Hanna Instruments, Johannesburg, South Africa) according to a previously described method by (Ferrer *et al*., 2005). Titrable acidity of the juice was determined by titration with sodium hydroxide (0.1 N) to pH 8.10. The results were expressed as % malic acid as presented in equation 2 (Ferrer *et al*., 2005; Chen & Opara, 2013; Al-Yahyai *et al*., 2009).

$$TA = \text{titre (ml)} \times \text{acid factor} \times 100^{-10\ \text{(ml) juice}},\ \text{malic acid: } 0.0067 \quad (2)$$

2.4.3 Statistical analysis

Statistical analysis was carried out using the GenStat 14$^{th}$ version for the analysis of variance (ANOVA) for each of the three replicated five degree of ripeness parameters measured. Significant differences were set at the 5% level ($p < 0.05$), and a multiple range Tukey's test was used to separate means.

## 3. RESULTS AND DISCUSSION

Fruitlets marked after full bloom to determine the number of days to maturity resulted in fruit reaching maturation at 129 days, a constant mass averaged at 80 g and volume averaged at 55.20 cm$^3$. This is within a range of 70 to 130 days reported by Sutasinee, Kozai, Beppu and Kataoka (2005), for fruit development after full bloom to maturity. It was conclusive that the fruit reaches maturity and starts ripening at 129 days after full bloom and this is one of the parameters that can be used by small-scale peach growers to estimate the harvest dates for their peach crop at Impendle.

### 3.1 Fruit mass

Figure 1 displays the results of fruit mass. Fruit mass was significantly ($p < 0.001$) different between the different degrees of ripeness. No major differences in mass were noted between green, pale-green, pale-white and whitish degrees of ripeness at the 5% level of significance. However, white degree of ripeness was the most significantly different from all other degrees of ripeness and had the highest mass. These results are in agreement with those previously reported by Dejong and Goudriaan (1989) and Shinya *et al.*, (2014) who reported that the riper the peach fruit, the greater the mass. Our results confirmed that mass can be used to estimate how far the fruit has grown, since mass increased with maturity. Mass can be incorporated as a maturity index for peach fruit.

## 3.2 Fruit colour

### 3.2.1 CIELab coordinate, L*

The results for fruit peel colour lightness are presented in Table 1. The chromatic scale lightness (L*) had no statistically ($p < 0.05$) significant differences in all five degrees of ripeness, however, it showed signs of increasing from green to white. Moreover, it is clear that the L* values were increasing from mature green to white. Forcada, Gradziel, Gogorcena and Moreno (2014) concluded, after determining peach and nectarine in 90 cultivars, that L* ranges between a minimum of 10.6 and a maximum of 76.8 for the *Prunus persica* (L.) Batsch. The L* values of the current study averaged at 61.4 including green and white fruit colours and within the range found by Forcada *et al*. (2014). However, L* cannot be used conclusively as a parameter to determine ripeness for the white peach of a small-scale grower since slight insignificant changes take place.

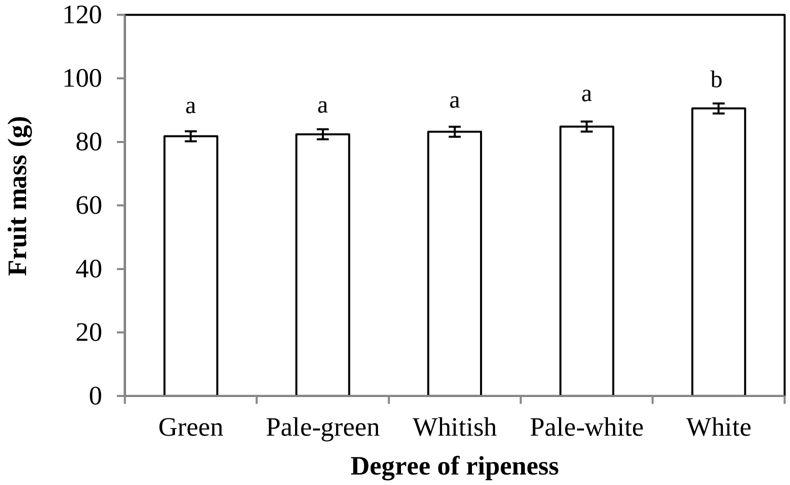


**Figure 1:** Fruit mass determined between five degrees of ripeness for the white Impendle peach landrace.

Note: Error bars represent standard error of the mean, $LSD_{0.05}$ is least significant difference at 5% level of significance and CV is co-efficient of variation. $LSD_{0.05}$ = 2.31, CV = 7.50%.

### 3.2.2 CIELab coordinate, a*

The results of greenness/redness (a*) are also presented in Table 1. The CIELab a* coordinate showed statistically significant differences ($p \leq 0.05$) with an average of 5.54 value. The value of a* at mature green degree of ripeness was the highest and decreased from mature green to pale-green. The a* value increased from pale green to whitish, then decreased from whitish to pale white, and increased from pale white to white. There was no clear stable trend between degrees of ripeness from mature green to white as the value of a* change was up and down, nevertheless, the value decreased from mature green to white overall. However, the differences do not have a trend that can be followed when determining the ripeness of the peach landrace. Prinsi *et al.* (2011) reported an increase in colour index 'a*' whereby it increased from -7.32 to 4.58. The current study findings were not congruent to those reported by Prinsi *et al.* (2011). Orazem, Mikulic-Petkovsek, Stampar & Hudina (2013) suggested the use of a* value as a suitable maturity index, since this is the colour coordinate that changes the most during maturation. Ferrer *et al.* (2005) and Herrero-Langrero, Fernández-Ahumada, Roger, Palagós and Lleó (2011) also reported that CIELab coordinate a* changes linearly during peach maturation. Due to an unstable trend, conclusively the a* parameter is not a clear parameter that can be used to determine ripeness, based on the current study results. However, the figure was used to calculate hue angle and the chroma in the study.

3.2.3 CIELab Coordinate, b*

Furthermore, Table 1 also displays the results of blueness/yellowness (b*). Chromatic scale b* showed statistically significant differences ($p \leq 0.05$). The b* values increased from green to pale green, from pale green to whitish, from whitish to pale white, and lastly from pale white to white. Evidently there was an increasing trend of b* as the ripening increased. Herrero-Langrero *et al.* (2011) reported study results about a range of b* between 8.9 and 69.1 values and the current study b* values averaged at 38.41 in the explained range. With such an increasing trend, it is clearly a sign that as b* increases, the fruit ripening process also continues and, therefore, this is one of the parameters that can be determined for the small-scale growers' fruit in order to determine maturity or ripening stage of the fruit. The value was used to determine hue angle and chroma in the study.

**Table 1:** The L*, a* and b* chromatic scales of five different degrees of white peach ripeness.

| **Degree of ripeness** | **L*** | **a*** | **b*** |
|---|---|---|---|
| Green | 60.86[a] | 9.49[a] | 34.64[a] |
| Pale green | 61.32[a] | 3.33[a] | 37.48[ab] |
| Whitish | 61.36[a] | 6.62[ab] | 39.60[b] |
| Pale white | 59.41[a] | 2.92[a] | 39.99[b] |
| White | 63.13[a] | 5.36[ab] | 40.36[b] |
| Grand mean | 61.40 | 5.54 | 38.41 |
| F Prob. (5%) | 0.84 | 0.03 | 0.11 |
| LSD (5%) | 8.49 | 4.26 | 4.74 |
| CV | 10.50% | 58.20% | 9.40% |

Note: Different letters denote statistically significant differences in parameters by Tukey's multiple range tests at $P < 0.05$ among different ripeness degrees.

### 3.3 Fruit Volume

There were statistically significant differences in fruit volume ($p < 0.05$) in all five different degrees of ripeness (Table 2). The fruit volume increased from 53.30 to 66.10 $cm^3$ during ripening. This was a trend noticed as the fruit ripened and could be linked to the fruit mass increase.

**Table 2:** Volume of five fruit ripeness degrees

| **Degree of ripeness** | **Volume (cm$^3$)** |
|---|---|
| Green | 53.30[a] |
| Pale green | 53.90[ab] |
| Whitish | 55.30[a] |
| Pale-white | 47.40[a] |
| White | 66.10[ab] |
| Grand mean | 55.20 |
| F Prob. (5%) | 0.07 |
| LSD (5%) | 12.48 |

Note: Different letters denote statistically significant differences in parameters by Tukey's multiple range tests at P < 0.05 among different ripeness degrees.

### 3.4 Percentage moisture content

The moisture content percentage averaged at 83% (see Table 3) for five different degrees of ripeness, but showed no statistically significant differences ($p > 0.05$). This parameter could not be linked to ripeness of peach fruit.

**Table 3:** Percentage moisture content of five white peach ripeness degrees.

| **Degree of ripeness** | **Moisture content (%)** |
|---|---|
| Green | 85.00[a] |
| Pale green | 84.00[a] |
| Whitish | 82.00[a] |
| Pale-white | 82.00[a] |
| White | 82.00[a] |
| Grand mean | 83.00 |
| F Prob. (5%) | 0.72 |
| LSD (5%) | 6.56 |

Note: Different letters denote statistically significant differences in parameters by Tukey's multiple range tests at P < 0.05 among different ripeness degrees.

### 3.5 Hue angle

The results of lightness's (hue) angle are presented in Table 4. Hue angle in white peach landrace did not show significant differences ($p > 0.05$). It started high in green peach and showed a significant decrease as the peach matures and changing to white. However, the trend is not smooth and has some inconsistencies. Thus, it makes it difficult to be a reliable parameter that can be used as a maturity index for the white peach landrace grown by small-scale growers in South Africa. However, the current study results averaged at 39° for the hue angle and this is within a range of 16.9 and 91.4 as described by Forcada *et al*. (2014). The challenge was that hue angle never showed conclusive results since no trend was specified or differences between different ripeness degrees. Furthermore, there were no relationships between the chroma of the different ripeness degrees. Chroma therefore is not a useful tool to determine ripeness stage in small-scale peach grower's crop.

**Table 4:** Hue angle of white peach fruit determined at five stages of ripeness degrees.

| **Degree of ripeness** | **Hue Angle (°)** |
|---|---|
| Green | 37.93[a] |
| Pale green | 40.53[a] |
| Whitish | 36.91[a] |
| Pale-white | 39.85[b] |
| White | 39.78[a] |
| Grand mean | 39.00 |
| F Prob. (5%) | 0.025 |
| LSD (5%) | 2.17 |

Note: Different letters denote statistically significant differences in parameters by Tukey's multiple range tests at P < 0.05 among different ripeness degrees.

The lack of significant differences could be related to this crop being a white variety, whereby there are less activities related to ground colour changing or red and orange components that take place in yellow peaches (Brovelli, Brecht & Sherman, 1998). Fruit colour results showed that only b* determined individually could be used as a tool to determine colour change in peaches during the ripening process. However, hue and chroma were unable to conclusively determine the ripeness stage in the study.

### 3.6 Chroma

The results on peach chroma are presented in Table 5. There were no significant differences in chroma ($p > 0.05$). The chroma average value of 81.6 was slightly above the range of 25.3 – 80.6 as described by (Brovelli *et al*., 1998).

**Table 5:** Chroma scale of five white peach ripeness degrees.

| **Degree of ripeness** | **Chroma** |
|---|---|
| Green | 79.26[a] |
| Pale green | 79.82[a] |
| Whitish | 82.14[a] |
| Pale-white | 83.24[a] |
| White | 83.69[a] |
| Grand mean | 81.6 |
| F Prob. (5%) | 0.025 |
| LSD (5%) | 6.80 |

Note: Different letters denote statistically significant differences in parameters by Tukey's multiple range tests at P < 0.05 among different ripeness degrees.

### 3.7 Fruit firmness

Fruit firmness, as displayed by Figure 2, showed highly significant ($p < 0.001$) differences and a clear trend was evident as the fruit firmness changed from green to whitish ripening stages and could be used as a good indicator of ripeness in white peach landrace. Fruit firmness decreased during the change in ripeness degree from 79 N for the green to 24.7 N for the white stage. This was a clear trend which evidently showed constant decrease in fruit firmness. Prinsi *et al.* (2011) reported results on a study on peach firmness measured on unripe and ripe fruit, and the conclusion was that firmness decreases with ripeness from unripe to ripe degree. However, when the fruit is too soft, the needle is less sensitive (Shinya *et al.*, 2014).

The results obtained from this study were congruent with that of Prinsi *et al.* (2011) and Shinya *et al.* (2014). With such congruency with literature, the current study results do confirm that the fruit firmness is an important tool to use in determining the ripeness stage in peach fruit.

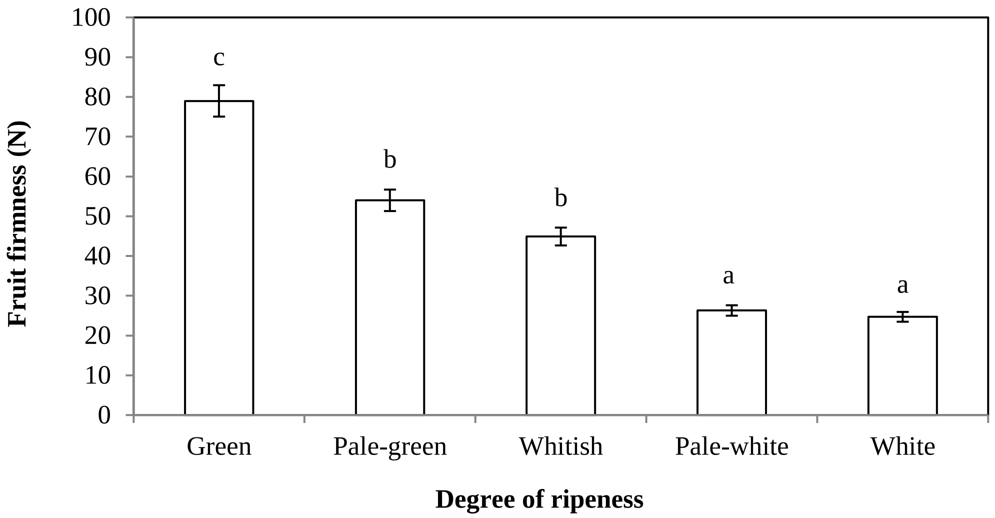


**Figure 2:** Fruit firmness at five different degrees of ripeness for the white peach landrace.

Note: Error bars represent standard error of the mean, $LSD_{0.05}$ is least significant difference at 5% level of significance and CV is co-efficient of variation. $LSD_{0.05}$ = 2.32. CV = 11.00%.

### 3.8 Total soluble solids

Total soluble solids were highly significantly different ($p < 0.05$) ranging from the green to the whitish degrees of ripeness with the pale green fruit having a lower TSS (13.5 °Brix) than white fruit (19.0 Brix) (Figure 3). Cascales, Costell & Romojaro (2005) reported study results whereby TSS increased from 11.5 to 13.1 °Brix. Prinsi *et al.* (2011) reported their study results whereby peach TSS was determined at two different ripening degrees, that from unripe to ripe where there was a significant increase in TSS levels. It can be confirmed that the small-scale grower’s peach follows the trend confirming that TSS increases during peach ripening (Brovelli *et al*., 1998).

### 3.9 Fruit pH and titrable acidity

The fruit pH, as indicated by Figure 4, showed statistically significant ($p < 0.05$) differences in pulp pH ranging from 3.4 in pale-green to 4.0 in whitish fruit. Both green and pale-green pH had statistically significant differences from whitish with an LSD = 0.36 and grand mean =3.6. There were no significant ($p > 0.05$) differences on titrable acidity and the average for different degrees of ripeness was 0.63% malic acid. Cascales *et al.* (2005) reported a decrease of malic acid from 0.68% of the unripe fruit to 0.58% to the ripe fruit, whereas, in the current study, malic acid remained constant in all five degrees of ripeness. The study on peach ripening conducted by Prinsi *et al.* (2011) showed a decrease in juice pH from unripe to ripe peaches, which the current study has also proven, and congruent results have been recorded.

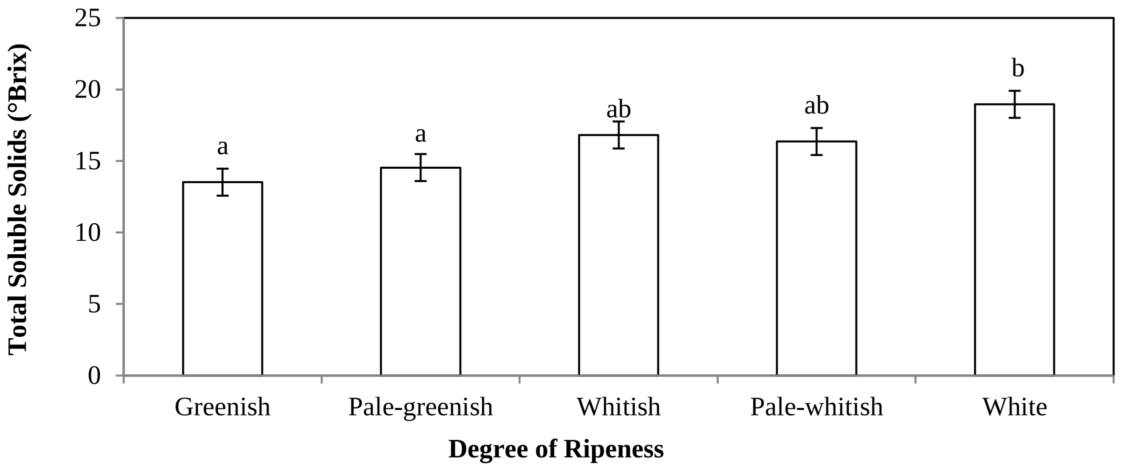


**Figure 3:** Total soluble solids of five different degrees of ripeness for the white Impendle peach landrace.

Note: Error bars represent standard error of the mean, $LSD_{0.05}$ is least significant difference at 5% level of significance and CV is co-efficient of variation. $LSD_{0.05}$ = 2.1, CV = 9.60%.

With transition of maturity degrees from mature-green to whitish, the pH increased significantly.

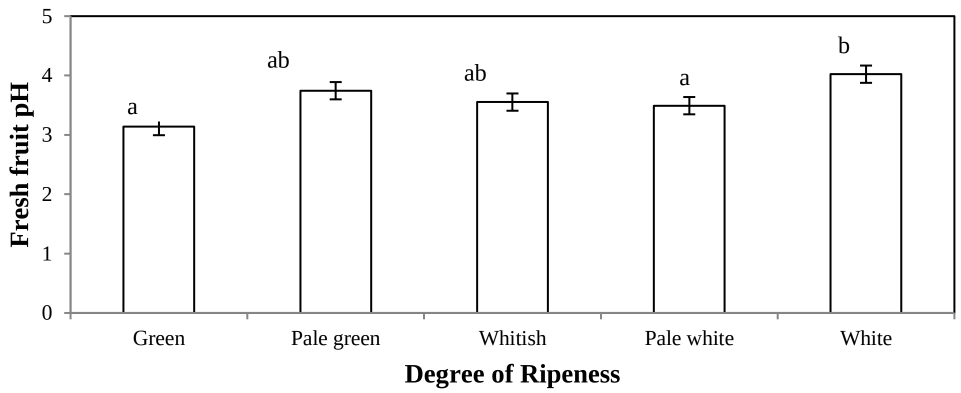


**Figure 4:** The peach fruit pH determined at five different degrees of ripeness for the white Impendle peach landrace.

Note: Error bars represent standard error of the mean, $LSD_{0.05}$ is least significant difference at 5% level of significance and CV is co-efficient of variation. $LSD_{0.05}$ = 0.365, CV = 7.60%.

### 3.10 TSS:TA ratio

Peach TSS:TA ratio was determined and is presented in Figure 5. There were significant differences ($p < 0.05$) in different degrees of ripeness. The ratio was increasing with maturity, however, between green, pale green, whitish and pale whitish, there were no statistically significant differences, even though there was an increasing trend. White peach had the highest ratio and significantly different from all other degrees of ripeness. The increase ranged between 21.11 and 35.84 and this increase is almost related to an increase previously reported by Cascales *et al.* (2005), in which the TSS:TA ratio ranged from 19.77 to 38.17. Magwaza *et al.* (2013) reported that TA, TSS and their ratios have a considerable variation during maturation and therefore are not reliable to give proper indexing since their ratios are not static. The current study's findings showed an increasing trend when it comes to TSS:TA ratio. However, the study showed that the increase is much more dependent on increasing TSS values, which increases with increasing maturity, and values of TA that decrease with decreasing ripeness from green to white (Figure 5). However, with an increased ratio for the whitish mature, since there is a lack of constant trend, the ratios cannot be used reliably to index maturity in peaches.

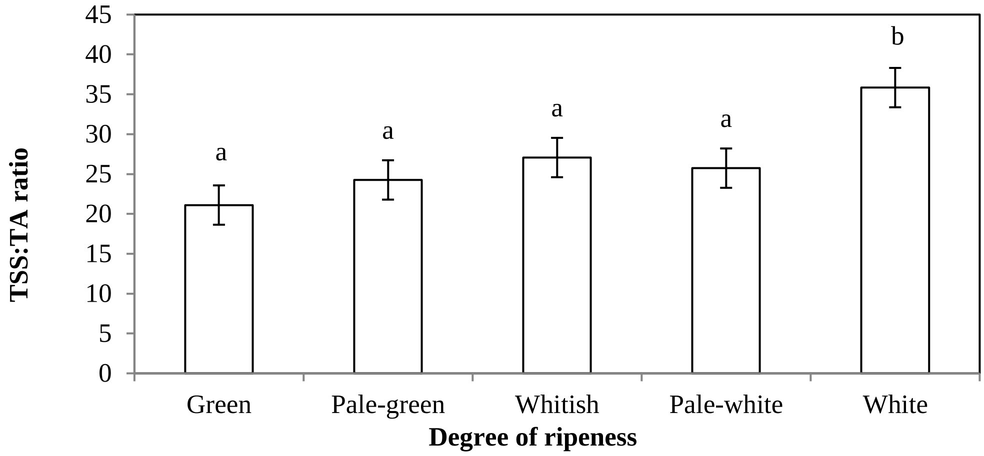


**Figure 5:** TTS:TA ratio of white clingstone peach landrace at different degrees of maturity or ripeness.

Note: Error bars represent standard error of the mean, $LSD_{0.05}$ is least significant difference at 5% level of significance and CV is coefficient of variation. $LSD_{0.05}$=5.37, CV = 15.20%.

## 4. CONCLUSION AND RECOMMENDATIONS

Documentation and availability of quality parameters data on fresh produce is important for a farmer in order to know the status of the product quality being handled, regardless of whether it is a small or large formal or informal operation. This information is important to maintain quality since it cannot be improved during postharvest, but likely to deteriorate quickly. The determination of peach fruit mass, volume, b*, TSS, pH, and PSS:TA ratio showed statistically significant ($p < 0.05$) differences during fruit ripeness from green to white. The colour of the fruit determined by hue angle and chroma did not show a noticeable trend that can be used in determining the fruit ripening stage. This result was inconclusive in determining peach ripeness. The fruit pH also showed a significant ($p > 0.05$) trend during fruit ripening, as it was determined in all five degrees of ripeness showing a decrease during ripeness. However, the role of determining TSS is crucial, since there is a steady increase as the fruit ripens. During the determination of fruit sugar to acid ratio, there was an increase in the acid ratio, which can be used as an indication of landrace ripeness. Fruit firmness showed a clear trend of a steady decrease as the fruit ripened from green to whitish degree of ripeness. The fruit is hard at green stage and becomes very soft at white ripeness degree. However, the use of firmness could slightly be linked with the use of a* CIELab coordinate during ripening. The study showed that firmness decrease, mass increase, acid decrease, TSS increase, 129 DAFB volume increase, and TTS:TA ratio increase all have important roles to play as parameters that can be used to tell maturity of white landrace peach fruit, especially for small-scale growers. The appearance of first flower in relation to the first fruit ready for consumption is comprised by 129 days in between. Hue angle, chroma, L* and b* as well as moisture content did not evidently show any significances in determination of maturity and ripeness of the white peach landrace grown by small-scale producers in South Africa. A close relationship between extension and research with a household farmer in-between will ensure that a farmer is obtaining the expected information and thus would be able to adopt and apply the information with support from extension officers. To provide support to a farmer, the current information is transferred through demonstration on how to determine such quality parameters by a farmer. Adopted methods should be made freely available to the farmers through the provision of all details in relation to extension and research with use of agri-updates in simplified and shortened versions of what to look for or to do.

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