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# Numerical Evaluation for Total Yield and Fruit Quality of Five Local Prickly Pear Strains under El-Monofia Governorate Conditions

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**ABSTRACT**
Field work of this investigation was carried out during the two successive seasons of 2019 and 2020 on ten - year- old commercial shrubs of the Egyptian prickly pear strains grown in sandy soil at 3 X 3 meters apart, in private orchard in El- Monofia Governorate, Egypt. The strains were evaluated relative to growth, yield and fruit quality. The obtained results could be summarized as follows:-The obtained results showed that, the highest value of cladodes properties and flowering characters expect flowering percentage and total yield were gained for fourth strain in both seasons. First strain produced the highest Flowering percentage and total yield followed by fourth strain while, the lowest values were gained for fifth strain and it ranged between (73.76 – 87.59% and 21.5 – 35.9 kg) in both seasons, respectively. Fruit weight and dimensions as well as seeds weight and number recorded the highest values by first strain followed by third strain while, the lowest values were gained for second strain followed by fourth strain and the fifth strain came intermediate. Concerning chemical parameters, the highest total sugar percentage ranged from 9.2 to 12.5 % and 10.9 to 13.8 % in the fruit pulp and peel and gained the highest percentage with third strain followed by second and first strains whereas, fifth and fourth strains recorded the lowest percentage without significant differences between them in both seasons, respectively. Reducing, non-reducing sugar percentage and pectin content in fruit pulp and peel as well as TSS % in pulp juice take similar trend of total sugar percentage. Second strain was recorded the highest TSS/acid ratio and ascorbic acid content followed by first strain while; the lowest values were gained by fourth and fifth strains. Total score for yield and fruit quality (100). First strain seemed to be the higher in the general evaluation score (96.4 unit) in the average of two seasons followed by third strain (90.87 unit) and fourth strain (89.68 unit) while, the lowest general evaluation score was gained by fifth strain (82.01 unit) followed by second strain (85.11 unit).

***Keywords*:** prickly pear, evaluation, cladodes, bud properties, fruit quality, buds characteristics, yield.

## Introduction

Prickly pear (*Opuntia SPP*) belongs to the family Cactaceae. This family comprises approximately 130 genera and 1500 species (Britton and Rose, 1963).The genus Opuntia is the largest one comprising more than 300 species (Benson, 1982). Prickly pear fruit is many- seeded berry with a thick peel enclosing a delecate flavourd plup full of seeds (Savio, 1987). Prickly pear plants play an ecological role in soil conservation projects for arid and semi-arid zones. Besides, producing fruit and vegetables (Nopalitos cv.) for human consumption (Hoffmen, 1980; Bustos, 1981; Sawaya and Khan, 1982; Sawaya *et al.*, 1983a; Sawaya *et al.*, 1983b and Retamal *et al.*, 1987), forage or fodder for livestock (Domingues, 1963; Russel and Felker, 1987; Zimmermann, 1988a and Felker, 1990), biomss for enegy purposes (fuel or biogas) (Varnero and Arellano, 1990; Varnero *et al.*, 1992 and Uribe *et al.*,1992), cochineal for carmine production, and numerous by products; i.e. beverages, vegetarian, chees drugs cosmetics (Baranyovits, 1978; Rodriguez, 1988; Tito, 1988 and Zimmermann,1988a). They also provide shelter and food for various wildlife species living in arid environments. Both fruit and cladodes of prickly pear are rich in slowly absorbed soluble fibers that may help keep blood sugar stable. More recently, prickly pear diffused as a fruit crop in California (Curtis, 1977), Sauth Africa (Wessels, 1988), Israel (Nerd and Mizrahi, 1993) and Chile (Sudzuki *et al.*, 1993). In Italy, prickly pear became the third fruit crop of Sicily

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after grape and olive but in Mexico, it was only during the fifties that modern commercial plantings began to develop, with a dramatic increase (from 10000 to more than 50000 ha) during the eighties (Pimienta, 1990).

In Egypt, the total area of prickly pear reahed about 2747 feddans (uniform agriculture), producing 27299 tons (11.84 tons / feddan) according to the offical records of Ministry of Agriculture 2002.

The variability in yield depends on orchard management and design, rather than on prevailing environmental constraints. In this respect, in Israel and Italy 15 to 25 t –ha are reported by (Nerd and Mizraahi, 1993 and Barbera and Inglese, 1993) .On the other hand, lower yield in chile (6-15t/ha) and Mexico (4-10t/ha) are reported with (Sudzuki *et al.*, 1993 and Pimienta, 1990). In South Africa 10-30t/ha are reported by (Wessels, 1988) with peaks of 33t/ha obtained in experimental farms. (Brutsch and Scott, 1991 and Arba *et al.*, 2017) mentioned that, the mean fruit yield was 16.5 – 31.26kg/shrub. Concerning physical fruit properties, Barbera *et al.*, (1992) and arba *et al.*, (2017) reported that both length and diameter of prickly pear fruit reaching 8.9 and 5.7cm at harvesting while, Kuti (1992) reported that the fruit length of four prickly pear species ranged between 9.0 and 17.0 cm. Sawaya *et al.*, (1983); D'hallewin and Mulas (1990); Nerd *et al.*, (1991); Kuti (1992); Barbera *et al.*, (1995); Zavaleta *et al.*, (2001); Alfredo and Marita (2003) and arba *et al.*, (2017) mentioned that Prickly pear fruit weight ranged between 92.3 and 140g/ fruit, flesh weight ranged from 56.4 to 80g and flesh percentage to the total fruit weight were about 61.8 while, Barbera *et al.*, (1992) how reported that average fruit weight retched 152.5 g at harvest stage, but Abdelal (1964) found that weight of prickly pear fruit 80.7 and 84.5gm, pulp weight percentage was 42.10 and 40.60% throughout the two seasons of his study. Seeds number and weight (Barbera *et al.*, 1995) reported that seed number ranged between 246 and 280 seed/fruit and seeds weight ranged from 3.5 to 4.59. Wessells (1989) and Nerd *et al.*, (1991) reveled that seed number/fruit gained 180 and 121, respectively. Barbera *et al.*, (1992) ; Kuti, (1992) and Alfredo and Marita (2003) reported that seeds number ranged between 302 – 326 seeds and between 3.62 – 4.59% from seed weight. Askar and El Samahy (1981); Sawaya *et al.*, (1983a); Russel and Felker (1987); Gideon *et al.*, (1989); Rizk and Al-nowaihi (1989); D' hallewin and Mulas (1990); Pimionta (1990); Sepulveda and Seenz (1990); Barbera *et al.*, (1992); Karim and Neven (2017) and Gamil *et al.*, (2012) they reported that total, reducing and non-reducing sugar percentage ranged between (10 – 14, 8.5 – 12 and 2.71 – 0.65) moreover, Abdelal (1964) and El Bana *et al.*, (2020) reported 6.35 and 6.52% for total sugar. Regarding TSS and TA, the available review reported that TSS increased while, TA decreased at harvest stage. The value ranged between 8- 15.8% and 0.01- 0.302% for TSS and TA respectively this variation may be due to different species or maturity and ripeness of the fruits. Askar and El-Samahy (1981); Schmidt-Hebbel and Pennacchiotti (1985); Wessells (1989); D' Hallenwin and Mulas (1990); Kuti (1990); Pimienta (1990); Nerd *et al.*, (1991); Barbera *et al.*, (1992 and 1995); Gamil *et al.*, (2012); Arba *et al.*, (2017); Karim and Neven (2017) and El Bana *et al.*, (2020). Paredes and Rojo, (1973);Askar and El-Samahy, (1981); Pimienta, (1990); Sawaya *et al.*, (1983b); Sepulveda and Saenz, (1990) and Gamil *et al.*, (2012); Karim and Neven (2017) they revealed that a high level of ascorbic acid in prickly pear fruit juice ranged between 20 and 41 mg/100g)

This study was planned to gain more information on some local prickly pear strains and evaluated relative to growth (cladodes and buds characteristics), yield and fruit quality (physical and chemical fruit properties).

## Materials and Methods

Field work of this investigation was carried out during the two successive seasons of 2019 and 2020 on ten - year- old commercial shrubs of the Egyptian prickly pear strains grown in sandy soil at 3 X 3 meters apart, in private orchard in El- Monofia Governorate, Egypt. The five different prickly pear strains could be distinguished according to high yield, peel and pulp color, cladodes aria, seeds number and weight and good fruit taste in light of gardeners. The necessary samples were obtained from 45 healthy mature prickly pear seedling shrubs, each shrub were of nearly uniform size and vigour and were thoroughly subjected to the daily cultural practices followed by

the orchard management such as irrigation and fertilization through their life. The shrubs were evaluated relative to the following aspects:-

**1. Cladodes and buds characteristics**

At the beginning of each growing seasons one year old five cladodes were selected on each shrub to take the following parameters:

1. Average cladode length and diameter (Cm).
2. Average cladodes thickness (cm) by using Varner caliper.
3. Average cladode weight (g)
4. Average number of swollen on upper surface.
5. When the number of burst buds became constant, the number of total, flowering and vegetative buds was accounted.
6. The percentage of flowering buds was calculated with respect to the total number of buds as follow:-

$$Flowering\ bud\ percentage = \frac{Flowering\ buds}{Total\ buds} \times 100$$

7. Yield /plant (Kg) was determined by multiplying number of the flowering buds /plant by average fruit weight

**2. Fruit physical and chemical characteristics:**

At the commercial ripening stage (when the flesh became yellowish) Ten fruits from each replicate were picked. Within each fruit sample, the following characteristics were studied:

1. Average fruit dimension; Fruit length (cm.); fruit diameter (cm); and fruit shape (length/ diameter).
2. Average fruit weight; whole fruit (g); fruit pulp (g); fruit peel (g) and seed weight (g).
3. Pulp percentage / fruit.
4. Number of seed/fruit accounted.
5. Moisture percentage in fruit pulp and peel by oven drying at 70$^{o}$ C until constant weight.
6. Total soluble solids percentage (TSS %) in the pulp juice using abb refractometer.
7. Titratable acidity percentage (TA) in the fruit pulp and peel juice was determined as anhydrous citric acid (Kuti, 1992) according to A.O.A.C (2005).
8. The TSS/acid ratio was also calculated with divided TSS / TA.
9. Percentage of the sugars content was determined according to Lans & Eynon volumetric method that outlined in A.O.A.C (2005).
10. Ascorbic acid (Vitamin C) content was determined in pulp and peel juice as mg/100gm fresh weight according to A.O.A.C (2005).
11. Pectic substances were determined according to the procedure described by Roase and Atkins (1955).

**3. Quality and general evaluation: -**

Evaluation of the tested prickly pear strains was calculated on the basis of 100 units which were divided among the various fruit properties according to (Hamed, 2012) with simple modification as follows: 30 unite for the yield/plant, 15 units for fruit weight, 15 units for pulp %, 5 units for each fruit length and diameter, 10 units for each TSS and total sugars content and 5 units for each of acidity and ascorbic acid content. Each strain that gave the best results in any character was given the full mark specified for this character, while each of the other tested strains took lower units to their qualities.

**Statistical analysis**

The layout of this experiment was a randomized complete block design. Each treatment contained from 9 shrubs (3 replicates and 3 shrubs per replicate). The obtained date was statistically analyses according to complete randomized blocks design with 3 replicates (Snedecor and Cochran, 1980). The individual comparisons between the obtained values were carried out at the 5% level of New LSD.

**Results and Discussion**

**1. Cladodes characteristics**

The data in table (1) showed that prickly pear strain under this study deferred significantly concerning all parameter expect cladode thickness in both seasons. As for cladode length, number of swollen in upper surfaces and cladode weight tack the smeller trend. The highest value of this parameters were gained by fourth strain (75.6, 49.7 and 2.17 kg, respectively) in the first season (74.9 cm, 51.1 and 2.23 kg, respectively) in the second one, followed by third strain (53.2 cm, 43.9 and 1.97 kg, respectively & 55.1 cm, 45.1 and 1.93 kg, respectively) in the first and second seasons, respectively while, the lowest value was recorded by first and second strains without significant differences between them. Fifth strain came in between.

Regarding diameter of cladode, both third and fourth strains cladodes were nearly similar in diameter recording the highest diameter without significant in the first season (25.7 and 24.5 cm, respectively) and it was significant in the anther season recording (24.7 and 22.1 cm, respectively) while, the lowest diameter of cladode was recorded by second and first strains without significant differences between them in both seasons.

**Table 1:** Cladodes properties of five prickly pear strains during 2019 and 2020 seasons.

| | Cladodes length (cm) | Cladodes diameter (cm) | Cladodes thickness (cm) | Number of swollen on upper surface | Cladodes Weight (kg) |
|---|---|---|---|---|---|
| | | **2019** | | | |
| **First strain** | 44.2 | 19.9 | 1.37 | 41.3 | 1.51 |
| **Second strain** | 41.6 | 21.3 | 1.69 | 41.9 | 1.53 |
| **Third strain** | 53.2 | 25.7 | 1.39 | 43.9 | 1.97 |
| **Fourth strain** | 75.6 | 24.5 | 1.45 | 49.7 | 2.17 |
| **Fifth strain** | 47.3 | 23.1 | 1.45 | 45.3 | 1.72 |
| **New LSD at 5%** | 3.33 | 1.97 | N.S | 1.73 | 0.27 |
| | | **2020** | | | |
| **First strain** | 45.9 | 20.1 | 1.41 | 43.1 | 1.53 |
| **Second strain** | 42.7 | 21.9 | 1.71 | 42.9 | 1.63 |
| **Third strain** | 55.1 | 24.7 | 1.37 | 45.1 | 1.93 |
| **Fourth strain** | 74.9 | 22.1 | 1.45 | 51.1 | 2.23 |
| **Fifth strain** | 46.3 | 22.9 | 1.44 | 49.3 | 1.85 |
| **New LSD at 5%** | 3.2 | 1.85 | N.S | 1.51 | 0.17 |

**1.2. Flowering characteristics**

Data in Table (2) cleared that Number of total, flowering and vegetative buds as well as the percentage of flowering buds were significantly affected between tested prickly pear strains plants. Fourth strain plants produced the highest total, flowering and vegetative buds in both seasons followed by third strain plants, whereas the lowest number of the three parameters was gained for fifth strain plants. Anyhow, the total number of bud ranged between (9.5 and 6.3) and between (10.3 and 6.9) while, the flowering bud ranged from 7.40 to 4.73 and from 7.91 to 5.19 in the first and second seasons, respectively. The flowering bud percentage ranged between (82.23 & 75.07%) in the first season and between (87.59 & 73.76%) in the second one. The highest and lowest percentage of flowering bud was recoded for first and fifth strains, respectively in both seasons. Anyhow, the obtained results of burst buds under this study took a similar trend was found by Nerd *et al.*, (1991and 1993).

**1.3. Total yield / tree**

The data reported that the five strains of prickly pear plants differed significantly concerning average of total yield in both seasons. Fourth and first strains produced the highest average total yield / tree (33.1 – 33.3 and 29.9 – 35.3 kg), followed by third strain (27.3 – 25.7 kg) in the first and second seasons, respectively. The lowest average of total yield (22.7 – 21.5 kg) was gained by fifth strain in the two seasons, respectively. the obtained yield were almost similar to those found

by Wessels, (1988); Brutsch and Scott, (1991); Nerd and Mizraahi, (1993); Barbera and Inglese, (1993) and arba *et al.*, (2017) while, this results higher than those reported by Gatheara *et al.*, (1989); Gideon *et al.*, (1989); Pimienta, (1990); Sudzuki *et al.*, (1993) and Zavaleta *et al.*,(2001)

**Table 2:** Flowering properties and yield/plant of five prickly pear strains during 2019 and 2020 seasons.

| | Total buds /cladode | Flowering buds /cladode | Vegetative buds /cladode | Flowering percentage | Total yield / tree |
|---|---|---|---|---|---|
| | | **2019** | | | |
| **First strain** | 9.6 | 6.35 | 1.35 | 82.23 | 29.9 |
| **Second strain** | 7.9 | 5.99 | 1.91 | 75.82 | 25.9 |
| **Third strain** | 8.7 | 6.87 | 1.83 | 78.96 | 27.3 |
| **Fourth strain** | 9.5 | 7.40 | 2.10 | 77.89 | 33.1 |
| **Fifth strain** | 6.3 | 4.73 | 1.57 | 75.07 | 22.7 |
| **New LSD at 5%** | 1.93 | 1.03 | 0.625 | 2.87 | 5.27 |
| | | **2020** | | | |
| **First strain** | 8.3 | 7.27 | 1.03 | 87.59 | 35.3 |
| **Second strain** | 8.1 | 6.33 | 1.77 | 78.14 | 23.9 |
| **Third strain** | 8.9 | 7.01 | 1.89 | 78.76 | 25.7 |
| **Fourth strain** | 10.3 | 7.91 | 2.39 | 76.79 | 33.3 |
| **Fifth strain** | 6.9 | 5.09 | 1.81 | 73.76 | 21.5 |
| **New LSD at 5%** | 1.87 | 1.39 | 0.091 | 2.59 | 4.33 |

## 2. Physical fruit properties

### 2.1. Fruit dimension

The highest fruit length (8.90 and 8.73 cm) was recorded for the first strain followed by the fifth and third strains (8.09 &7.93 and 8.03 &8.09 cm) without significant differences between them in the first and second seasons, respectively. Third strain gained the lowest fruit length (7.03 and 7.01 cm) in the two seasons, respectively. The data also cleared that; fruit diameter differed significantly in both seasons and takes the same direction of its length. Concerning fruit shape, the data in table (3) clarified insignificant differences between the studied prickly pear strains during the two seasons. The obtained results were in line with those found by Barbera *et al.*, (1992) and arba *et al.*, (2017) they reported that both length and diameter of prickly pear fruit reaching 8.9 and 5.7cm at harvesting and lower than those reported by Kuti (1992).

### 2.2. Fruit weight parameter

Total, pulp, peel and seed fruit weight as well as pulp percentage were significantly affected under the tested strains in the two seasons. However, the highest total fruit (125.7 &119.5 g) and fruit pulp (68.45 & 69.11 g) weights were recorded for first strain followed by third strain, whereas the lowest total and pulp weight (97.9 & 101.5 g and 52.8 &57.53, respectively) were gained by second strain in 2019 and 2020 seasons, respectively. Regarding pulp percentage, the data clarify significant differences between the strains under study during the two seasons. Anyhow, the highest pulp percentage (57.11 and 57.89 %) was recorded for the third strain, whereas the fifth strain gained the lowest percentage (52.97 and 53.94 %) in the first and second seasons, respectively.

Seeds weight and number were differed significantly in both seasons. Seeds weight ranged between 5.62 and 3.41 g, while seeds number ranged from 266 to 219 in the two seasons. First strain gained the highest weight and number, while the lowest value was recorded for fourth strain.

Regarding fruit weight, the obtained results were in line with those found by Sawaya *et al.*, (1983); D'hallewin and Mulas (1990); Nerd *et al.*, (1991); Kuti (1992); Barbera *et al.*, (1995); Zavaleta *et al.*, (2001); Alfredo and Marita (2003) and arba *et al.*, (2017) they mentioned that Prickly pear fruit weight ranged between 92.3 and 140g/ fruit, flesh weight ranged from 56.4 to 80g and flesh percentage to the total fruit weight were about 61.8 and lower than those reported by Barbera *et al.*, (1992) how reported that average fruit weight retched 152.5 g at harvest stage, but Abdelal (1964) reported fruit weight lower than those found in this investigation, he found that weight of prickly pear fruit 80.7 and 84.5gm, pulp weight percentage was 42.10 and 40.60%

throughout the two seasons of his study. Concerning seeds number and weight the results were in agreement with those reported by Barbera *et al.*, (1995) and higher than those found by Wessells (1989) and Nerd *et al.*, (1991) and lower than those found by Barbera *et al.*, (1992) ; Kuti, (1992) ; and Alfredo and Marita (2003).

**Table 3:** Physical fruit properties of five prickly pear strains during 2019 and 2020 seasons.

| | Fruit dimensions (cm) | | | Fruit weight (g) | | | | Pulp % | Seed number / fruit |
|---|---|---|---|---|---|---|---|---|---|
| | Length | Diameter | Length / diameter | Whole fruit | Pulp | Peel | Seed | | |
| | | | | | 2019 | | | | |
| **First strain** | 8.90 | 4.07 | 2.18 | 125.7 | 68.45 | 57.25 | 5.62 | 54.45 | 265 |
| **Second strain** | 7.03 | 3.01 | 2.33 | 97.9 | 52.80 | 45.10 | 4.11 | 53.93 | 256 |
| **Third strain** | 8.03 | 3.97 | 2.02 | 111.3 | 63.57 | 47.73 | 3.89 | 57.11 | 223 |
| **Fourth strain** | 7.93 | 3.33 | 2.38 | 101.3 | 55.40 | 45.90 | 3.81 | 54.68 | 219 |
| **Fifth strain** | 8.09 | 3.95 | 2.05 | 109.1 | 57.80 | 51.30 | 4.51 | 52.97 | 249 |
| **New LSD at 5%** | 0.23 | 0.09 | 0.07 | 1.73 | 2.09 | 1.69 | 0.97 | 2.37 | 7.65 |
| | | | | | 2020 | | | | |
| **First strain** | 8.73 | 4.03 | 2.17 | 119.5 | 69.11 | 50.39 | 5.59 | 57.83 | 266 |
| **Second strain** | 7.01 | 3.15 | 2.23 | 101.5 | 57.53 | 43.97 | 4.27 | 56.67 | 257 |
| **Third strain** | 8.09 | 3.89 | 2.08 | 113.3 | 65.59 | 47.71 | 3.41 | 57.89 | 233 |
| **Fourth strain** | 7.27 | 3.27 | 2.22 | 107.1 | 57.77 | 49.33 | 3.87 | 53.94 | 221 |
| **Fifth strain** | 7.93 | 3.91 | 2.03 | 107.7 | 58.27 | 49.43 | 4.71 | 54.10 | 253 |
| **New LSD at 5%** | 0.33 | 0.11 | 0.07 | 1.93 | 2.27 | 1.71 | 0.89 | 1.79 | 9.57 |

## 3. Chemical fruit properties

### 3.1. Moisture percentage in the fruit pulp and peel

The data cleared that moisture percentage in the fruit pulp and peel differed insignificantly in the two seasons. Moisture percentage in the fruit pulp ranged from 76.7 to 81.5 % and between 75.1 and 80.7, whereas in the fruit peel, it ranged between (79.9 – 87.5 %) and between (81.1 – 87.3 %) in the first season and the second one. This result were in line with those found by Gathaara *et al.*, (1989); Rizk and Al-Nowaihi (1989); Barbera *et al.*, (1992) and Gamil *et al.*, (2012) they reported that the moisture percentage of prickly pear fruits at harvest ranged between 79.18 - 85% and lower than those reported by Pimienta (1990) and D' Hallenwin and Mulas (1990).

### 3.2. Fruit pulp and peel sugar percentage

Concerning total, reducing and non-reducing sugar percentage in fruit pulp and peel, the data mentioned that significant differences between strains under this study in both seasons. However, the highest total sugar percentage in fruit pulp and peel (12.1 – 12.5 and 13.8 – 12.9 %) and reducing sugar percentage in fruit pulp and peel (11.1 – 11.6 and 12.7 – 11.9%) were gained by third strain followed by second strain whereas, the highest non-reducing sugar percentage in fruit pulp and peel (1.1 – 1.2 and 1.3 – 1.1%) was gained by first strain in the two seasons, respectively. In fruit pulp, fifth strain was recorded the lowest percentage of total sugar (9.9 – 9.2%), reducing sugar (9.4 – 8.5%) and non-reducing sugar (0.5 – 0.7%) while, in fruit peel, first strain recorded the lowest percentage of total sugar (10.9 – 11.1%) and reducing sugar (9.6 – 10.0%) whereas, the lowest non-reducing sugar percentage was gained by fifth strain (0.7 – 0.7%) in the first and second seasons, respectively. The obtained results are in harmony with those found by Askar and El Samahy (1981); Sawaya *et al.*, (1983a); Russel and Felker (1987); Gideon *et al.*, (1989); Rizk and Al-nowaihi (1989); D' hallewin and Mulas (1990); Pimionta (1990); Sepulveda and Seenz (1990); Barbera *et al.*, (1992); Karim and Neven (2017) and Gamil *et al.*, (2012) they reported that total, reducing and non-reducing sugar percentage ranged between (10 – 14, 8.5 – 12 and 2.71 – 0.65) moreover, the recorded total sugar percentage in the fruit pulp in this investigation were higher than those reported by Abdelal (1964) and El Bana *et al.*, (2020).

### 3.3. Pectin percentage

Total pectin percentage in fruit pulp and peel of the five prickly pear strains differed significantly during the two seasons. Third strain was recorded the highest total pectin in both fruit pulp and peel (2.39 – 2.37 and 2.79 – 2.69 %) followed by first strain. The lowest total pectin in both fruit pulp and peel were recorded for fifth strain (2.07 – 2.11 and 2.39 – 2.39 %) followed by fourth strain without significant differences between them in the first and second seasons, respectively. second strain came in between. These results are in agreement with those reported by Rizk and Al-Nowaihi (1989) and Barbera *et al.* (1992) and higher than those found by Swaya *et al.* (1983) and Sepulvedo and Sacnz (1990). They stated that pectin percentage in prickly pear fruits was low and ranged from 0.08 to 1%.

**Table 4:** Percentage of moisture, sugar characters and pectin in the fruit pulp and peel of five prickly pear strains during 2019 and 2020 seasons.

| | Moisture percentage | | Fruit pulp sugar percentage | | | Fruit peel sugar percentage | | | Pectin percentage | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pulp | Peel | Total sugar | Reducing sugar | Non-reducing sugar | Total sugar | Reducing sugar | Non-reducing sugar | Pulp | peel |
| | | | | | 2019 | | | | | |
| **First strain** | 78.9 | 85.1 | 10.9 | 9.8 | 1.1 | 10.9 | 9.6 | 1.3 | 2.37 | 2.76 |
| **Second strain** | 77.3 | 83.3 | 11.7 | 10.8 | 0.9 | 11.9 | 11.1 | 0.8 | 2.17 | 2.45 |
| **Third strain** | 81.5 | 86.7 | 12.1 | 11.1 | 1.0 | 1.8 | 12.7 | 1.1 | 2.39 | 2.79 |
| **Fourth strain** | 81.3 | 87.5 | 10.3 | 9.6 | 0.7 | 11.3 | 10.4 | 0.9 | 1.97 | 2.41 |
| **Fifth strain** | 76.7 | 79.9 | 9.9 | 9.4 | 0.5 | 11.1 | 10.4 | 0.7 | 2.07 | 2.39 |
| **New LSD at 5%** | N.S | N.S | 0.37 | 0.29 | 0.17 | 0.29 | 0.75 | 0.15 | 0.07 | 0.09 |
| | | | | | 2020 | | | | | |
| **First strain** | 79.1 | 87.2 | 10.5 | 9.3 | 1.2 | 11.1 | 10.0 | 1.1 | 2.21 | 2.61 |
| **Second strain** | 75.9 | 81.5 | 10.9 | 9.9 | 1.0 | 11.7 | 11.0 | 0.7 | 2.15 | 2.43 |
| **Third strain** | 80.1 | 83.5 | 12.5 | 11.6 | 0.9 | 12.9 | 11.9 | 1.0 | 2.37 | 2.69 |
| **Fourth strain** | 80.7 | 87.3 | 9.6 | 8.9 | 0.7 | 11.4 | 10.5 | 0.9 | 1.99 | 2.39 |
| **Fifth strain** | 75.1 | 81.1 | 9.2 | 8.5 | 0.7 | 11.5 | 10.8 | 0.7 | 2.11 | 2.39 |
| **New LSD at 5%** | N.S | N.S | 0.37 | 0.23 | 0.19 | 0.33 | 0.79 | 0.17 | 0.09 | 0.10 |

### 3.4. Total soluble solids (TSS)

The total soluble solids in the pulp juice (TSS) differed significantly in both seasons and take the similar trend of its total and reducing sugar percentage. The highest total soluble solids (13.7 and 13.5 %) was gained by third strain followed by second strain (13.1 and 13.3 %) whereas, the lowest total soluble solids (11.5 and 11.7 %) and (11.9 and 11.7 %) was gained by fourth and first strain without significant differences between them in the two seasons, respectively. The TSS percentage were in line with those reported for Askar and El-Samahy (1981); Schmidt-Hebbel and Pennacchiotti (1985); Wessells (1989); D' Hallenwin and Mulas (1990); Kuti (1990); Pimienta (1990); Nerd *et al.*, (1991); Barbera *et al.*, (1992 and 1995); Gamil *et al.*, (2012); Arba *et al.*, (2017); Karim and Neven (2017) and El Bana *et al.*, (2020) they found that total soluble solids gained 15.8 as highest % and 8% as a lowest

### 3.5. Titeratable acidity and TSS/acid ratio

Regarding total acidity percentage in pulp juice, the data mentioned that significant differences between the five strains in both seasons. Total acidity percentage in pulp juice ranged between (0.191 – 0.219%) in the first season and (0.189 – 0.229 %) in the second one. Total acidity percentage gained the lowest value with the first strain followed by second strain, while the highest total acidity percentage was recorded for fourth strain followed by fifth strain and the third strain came in between the five strains in the two seasons. These results were in agreement with those reported by Askar and El Samahy (1981); Sawaya *et al.*, (1983); Pimienta (1990); Sapulvedo and Sacnz1 (1990) and Kuti (1990) and lower than Kuti (1992); Arba *et al.,* (2017) and higher than those found by D' H allewin and Mulas (1990); Barbera *et al.*, (1992) and Alfredo and Marita (2003); Gamil *et al.*, (2012) and Karim and Neven (2017).

The data also revealed that, the differences in TSS/acid ratio values between the five strains were significant through both seasons. However, third strain gained the highest TSS/acid ratio (68.15) followed by second strain (66.49) in the first season. The vice versa between them was in the second season. Strain fourth gave the lowest TSS/acid ratio during the both seasons (52.51 and 51.09, respectively) followed with strains fifth and first without significant differences between them.

### 3.6. Ascorbic acid content

Ascorbic acid content in the pulp juice differed significantly between the studied strains in the two seasons. However second strain was gained the highest ascorbic acid content (41.9 and 40.7 mg/100 g fresh weight) while, first and third strain came after second one in the first and second seasons, respectively. The lowest value was recorded by fourth strain (35.1 mg/100 g fresh weight) followed by fifth strain in the first season. The vice versa was in the second season. The obtained result were near to the range reported by Askar and El-Samahy, (1981); Paredes and Rojo, (1973); Pimienta, (1990); Sawaya *et al.*, (1983b); Sepulveda and Saenz, (1990) and Gamil *et al.*, (2012) they revealed that a high level of ascorbic acid in prickly pear fruit juice ranged between 20 and 41 mg/100g) and higher than those found by Rizk and Al-Nowaihi (1989); Kuti (1990) and Karim and Neven (2017) but it was lower than those obtained by Kuti (1992).

**Table 5:** Total soluble solids, titeratable acidity, TSS/acid ratio and ascorbic acid content during 2019 and 2020 seasons.

| | Total soluble solids (TSS) | Total acidity | TSS / acid ratio | Ascorbic acid |
|---|---|---|---|---|
| | | **2019** | | |
| **First strain** | 11.9 | 0.191 | 62.30 | 40.6 |
| **Second strain** | 13.1 | 0.197 | 66.49 | 41.9 |
| **Third strain** | 13.7 | 0.201 | 68.15 | 39.3 |
| **Fourth strain** | 11.5 | 0.219 | 52.51 | 35.1 |
| **Fifth strain** | 12.3 | 0.209 | 59.83 | 37.6 |
| **New LSD at 5%** | 0.47 | 0.003 | 3.09 | 1.07 |
| | | **2020** | | |
| **First strain** | 11.7 | 0.191 | 61.25 | 40.1 |
| **Second strain** | 13.3 | 0.189 | 70.37 | 40.7 |
| **Third strain** | 13.5 | 0.205 | 65.85 | 39.2 |
| **Fourth strain** | 11.7 | 0.229 | 51.09 | 37.3 |
| **Fifth strain** | 12.5 | 0.207 | 60.38 | 35.3 |
| **New LSD at 5%** | 0.59 | 0.005 | 3.89 | 1.17 |

## 4. Numerical evaluation:

### 4.1. Total score for fruit quality (70 units)

The tested prickly pear strains could be arranged discerningly according to fruit quality parameters (70 units) as average of the two seasons as follows third strain (67.58unit), first strain(66.86unit), second strain (63.21 unit), fifth strain (63.59 unit) and fourth strain (60.53 unit).

### 4.2. General evaluation

Total score for yield and fruit quality (100). Data pertaining the general evaluation of the studied prickly pear strains in Table (6) revealed that prickly pear first strain seemed to be the higher in the general evaluation score (96.4 unit) in the average of two seasons followed by third strain (90.87 unit) and fourth strain (89.68 unit) while, the lowest general evaluation score was gained by fifth strain (82.01 unit) followed by second strain (85.11 unit).

**Table 6:** General score evaluation of five prickly pear strains during 2019 and 2020 seasons.

| | Units specified | First strain | Second strain | Third strain | Fourth strain | Fifth strain |
|---|---|---|---|---|---|---|
| | | | **2019** | | | |
| **Yield** | **30** | 29.09 | 23.49 | 24.74 | 30.00 | 20.57 |
| **Fruit weight** | **15** | 15.00 | 11.68 | 13.28 | 12.08 | 13.01 |
| **Pulp %** | **15** | 14.30 | 14.16 | 15.00 | 14.36 | 13.91 |
| **Fruit length** | **5** | 5.00 | 3.94 | 4.51 | 4.45 | 4.54 |
| **Fruit diameter** | **5** | 5.00 | 3.69 | 4.87 | 4.09 | 4.85 |
| **Total sugar** | **10** | 9.00 | 9.66 | 10.00 | 8.50 | 8.18 |
| **TSS** | **10** | 8.68 | 9.56 | 10.00 | 8.39 | 8.97 |
| **Acidity** | **5** | 5.00 | 4.84 | 4.75 | 4.36 | 4.56 |
| **Ascorbic acid** | **5** | 4.84 | 5.00 | 4.68 | 4.18 | 4.48 |
| **Total scour fruit quality** | **70** | 66.82 | 62.53 | 67.09 | 60.41 | 62.50 |
| **Total scour** | **100** | 95.91 | 86.02 | 91.83 | 90.41 | 83.07 |
| | | | **2020** | | | |
| **Yield** | **30** | 30.00 | 20.31 | 21.84 | 28.30 | 18.27 |
| **Fruit weight** | **15** | 15.00 | 12.74 | 14.22 | 13.44 | 13.51 |
| **Pulp %** | **15** | 14.98 | 14.68 | 15.00 | 13.97 | 14.01 |
| **Fruit length** | **5** | 5.00 | 4.01 | 4.63 | 4.16 | 4.54 |
| **Fruit diameter** | **5** | 5.00 | 3.90 | 4.82 | 4.05 | 4.85 |
| **Total sugar** | **10** | 8.40 | 8.72 | 10.00 | 7.68 | 7.63 |
| **TSS** | **10** | 8.66 | 9.85 | 10.00 | 8.66 | 9.25 |
| **Acidity** | **5** | 4.94 | 5.00 | 4.60 | 4.12 | 4.56 |
| **Ascorbic acid** | **5** | 4.92 | 5.00 | 4.81 | 4.58 | 4.33 |
| **Total scour fruit quality** | **70** | 66.90 | 63.90 | 68.08 | 60.66 | 62.68 |
| **Total scour** | **100** | 96.90 | 84.21 | 89.92 | 88.96 | 80.95 |
| **Av. Two seasons fruit quantity** | **70** | 66.86 | 63.21 | 67.58 | 60.53 | 62.59 |
| **Av. Two seasons total scour** | **100** | 96.40 | 85.11 | 90.87 | 89.68 | 82.01 |

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