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Evaluation of Growth and Yield Characters of Some Egyptian Onion (*Allium Cepa* L.) Cultivars and Their Phytochemical Composition Under Middle Egypt Conditions

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ABSTRACT

The present investigations were conducted during the two seasons of 2023 and 2024, to evaluate the vegetative, yield parameters and economic feasibility of eight local Egyptian onion cultivars (Giza 6, Giza 20, Giza 6 oblong, Sabeeni, Giza white, Shandweel 1, Giza red, and Composit 16) as well as, the study was extended to determine the phytochemical composition presented in all studied onion cultivars. The obtained results there were considerable difference between all various cultivars in almost studied vegetative growth traits. Concerning marketable yield, data showed that the three cultivars Composit 16 (14.51 and 14.47 tons/fed.), Giza 20 (14.12 and 14.41 tons/fed.) and Giza 6 oblong (13.99 and 14.05 tons/fed.**)** gave the best values of marketable yield as compared to other studied cultivars during both seasons, respectively. The primary conclusions of this investigation indicate that Composit 16 and Giza 20 cultivars provided the highest evaluation of economic values. The quantitative analysis showed that Giza red extract contained the highest concentration of phenolic and flavonoid components (25.88 mg GAE/g and 36.58 mg QE/g, respectively). The highest DPPH scavenging activities are shown by the methanolic extract (80%) of Giza White extract (103.62 µg/ml). Finally from the yield and economical point view, it could be concluded that among all studied Egyptian onion cultivars the three cultivars (Composit 16, Giza 20 and Giza 6) were the best for cultivation under experimental conditions. As well as, according to phytochemical analyses Giza red cultivar was superior more than all other cultivars.

Keywords Onion, total yield, bulb quality, phytochemical contents, economic feasibility.

1. Introduction

Onions (*Allium cepa* L.) are widely grown and consumed around the world (Pareek *et al.,* 2017). It has been described as a biennial, herbaceous crop that is cross-pollinated and a member of the Alliaceae family (Griffiths *et al.,* 2002). It is believed to have originated in southwestern Asia, which is a breeding area for diversity and is second only to tomatoes in terms of worldwide economic importance among all vegetables (Mallor *et al.,* 2014 and Brewster, 2008). The total area used for onion cultivation in Egypt was 94,457 hectares, yielding 3,312,469 metric tons, with an average yield of about 35 tons per hectare (FAOSTAT, 2023). The common onion varieties in red, yellow, and white, which come in three different colors, are typically available on the food market.

Typically, humans can eat all onion parts except the seeds (Currah, 2002). Most people use onions for their unique flavor or for their ability to enhance the flavor of other dishes. Additionally, they exhibit therapeutic qualities and are crucial for meeting human nutritional demands (Bagali *et al.,* 2012). The beneficial health effects of onions are mostly due to their large number of bioactive components, including their phenolic compounds, polysaccharides, and saponins (Marrelli *et al.,* 2019; Teshika *et al.,* 2019). Numerous studies have demonstrated the remarkable health benefits of onions and their

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bioactive compounds, including their antioxidant (Ouyang *et al.,* 2018), antimicrobial (Loredana *et al.,* 2019), anti-inflammatory (Jakaria *et al.,* 2019), anti-obesity (Lee *et al.,* 2016), anti-diabetic (Jini and Sharmila, 2020), and anti-cancer (Tsuboki *et al.,* 2016). Therefore, the main objectives of the investigation were to evaluate the vegetative, yield parameters and phytochemical profiles of eight local Egyptian onion cultivars and their economic feasibility under middle Egypt conditions.

2. Materials and Methods

This study was conducted in two successive winters seasons (2022–2023 and 2023/2024) at the Experimental Farm of the Sids Agricultural Research Station in the Beni–Suef Governorates, Egypt. The soil texture was clay-loam, physical and chemical properties of the used soil are listed in Table (1).

Table 1: Some physical and chemical analyses of the experimental soil.

Soil properties	Value
Particle size distribution (%)	
Coarse Sand	4.20
Fine sand	10.00
Silt	34.60
Clay	51.20
Texture grade	Clayey
ESP	16.50
Field capacity (%)	38.42
Wilting point (%)	17.06
Available water (%)	21.36
pH (1:2.5 soil-water suspension)	8.10
Calcium carbonate (%)	1.70
Organic matter (%)	1.25
EC, dSm^{-1} (soil paste extract)	2.50
Cation exchange capacity (mq/100 g)	36.60
Total nitrogen (%)	0.17
Soil available N (mg kg^{-1})	17.90
Soil available P (mg kg^{-1})	8.65
Soil available K (mg kg^{-1})	275.33

Seeds of eight Egyptian onion cultivars (Giza 6, Giza 6 oblong, Giza 20, Giza Red, Giza white, Shandaweel 1, Composit white 16 and Sabeeni) were obtained kindly from Onion Research Section, Field Crop Research, ARC, Giza, Egypt and sown in the first week of October at the nursery. Transplantation was carried out in the first of December (winter season). Four replicates of the experiment treatments were set up in a randomized complete blocks design (RCBD). The plot measured 10.5 m^2 (3.5 m in length by 3 m in breadth), with five ridges spaced 60 cm apart (1/400 fed.). Following hardening on both sides of ridges spaced 7 cm apart, uniform seedlings were transplanted. All necessary agricultural procedures, such as irrigation, nursery rearing, main field preparation, transplanting, fertilization, and weeding plant protection, were heavily advised for crop development in the middle Egypt region. The following information was gathered:

2.1. Vegetative growth characteristics

At 90 and 110 days following transplantation, samples of 10 onion plants from each experimental plot were randomly chosen in order to measure plant growth metrics such plant height (cm), number of green leaves per plant, and bulb diameter (cm). It was documented how many days passed between the maturity of the bulb and transplantation. The maturity stage was determined by the bulb neck softening (more particularly, the bulk of the leaves drying out and bending over) and 50% top-down bulb leaves.

2.2. The overall bulb yield and quality

Depending on the cultivar and region of cultivation, the crop was harvested on different days in May during both growing seasons. At maturity, between May 5 and May 9, 2024, most of the leaves had dried up and bent over. The whole bulb production was weighed at harvest time and divided into the local marketable yield (bulb diameter less than 4 cm and greater than 6 cm) and the culls (bulb types not suitable for consumption). In addition to recording the weight of each category (ton/fed.), one bulb's weight (g) was calculated using a sample of five bulbs taken from each plot. At harvest, ten guarded plants were randomly taken from the outer ridges of each plot to determine the total soluble solids (TSS) (%).

2.3. Storability of onion bulbs

Each plot's marketable harvest was put in regular burlap sacks and stored in a standard manner. After the harvested onion bulb are left in the field for the treatment of 3 weeks, under the shade, then the tops and roots were removed from every treatment. 100 marketable onion bulbs from each cultivar were randomly taken as a representative sample and kept under normal storage conditions. Each bulb was weighed using electronic digital gauge and its initial weight were including diameter. It was recorded and catalogued prior to its introduction in storage structure. Ambient storage atmosphere having 28. The maximum temperature is 32 ºC and the average minimum temperature is 18-15 ºC with 78-62% average relative humidity during storage seasons. Pathological and physiological activities of these bulbs were carefully monitored, such as rotted and sprouted bulbs throughout the storage period from May to November.

The storability of bulbs was calculated as a percentage of their overall weight loss throughout a six-month storage period. Total weight loss% was calculated by checking the yield every two months, discarding rotting and growing bulbs, and weighting the remaining yield. Every 60 days of storage, the percentage of total weight loss was computed using the following equation (Wills *et al.,* 1982).

$$\text{Weight loss\%} = \frac{\text{Initial weight - Weight after storage}}{\text{Initial weight}} \times 100$$

Remainder bulb % =100 - final weight loss %.

2.4. Economic analysis

The benefit-cost ratio and net return for each treatment were determined by economic research.

1. **Cost of cultivation**: Local prices for various agro-inputs, such as labor, fertilizer, compost, and other necessary items, were used to assess the cost of cultivation. The price of treatment cultivation was determined independently.

2. **Gross return:** Using the local market price for onions, the economic yield (measured in onion bulbs) was translated to a gross return (L.E. $fed.^{-1}$).To get the net return, the cost of cultivation was deducted from the gross return.

3. **The benefit-cost ratio** was calculated using the formula B:C ratio = gross return/cost of cultivation.

4. **Financial viability analysis**

The net income (LE) and economic profitability were calculated using the following economic criteria:

1: The impact of various treatments on the total costs of producing onions (LE/fed).
2: Total income (L.E./fed) = yield (ton/fed) (price L.E./ton).
3: The net farm return **(**L.E./fed) is the total revenue less total expenses.
4: Total income minus total costs equals the benefit/cost ratio (B/C).

As an average across the two seasons, one ton of marketable onions costs 2000 L.E., but one ton of cull onions costs 800 L.E. The economic return was calculated using the input cost and the current local market price of onion bulbs. The Cimmyt, (1988), calculations were used to do an economic evaluation.

2.5. Phytochemical analysis

2.5.1. Extraction procedure

Eight onion bulbs were randomly selected from each cultivar for extraction. The fleshy parts of each cultivar's onion bulbs were removed from their light, scaly leaves and cut into small pieces. They were then thoroughly mixed and dried in a 40°C air-circulating oven for 24 hours, and finally they were ground to a fine powder using an electric grinder overnight in a lab setting using 80% methyl alcohol in water (1:7 w/v) and a magnetic stirrer. With 80% v/v methanol and a magnetic stirrer, eight proposed onion cultivars (1:7 v/v) were separately extracted for 6 hours at room temperature. Filter paper was used to filter the crude extracts (Whatman No. 1). It was necessary to remove the plant tissue again and bulk it up. A rotary evaporator was used to evaporate the extracts at 4 ºC, and the residue was then frozen at -4 ºC for future research according to Davis *et al.* (2007) with minor modification.

2.5.2. Qualitative Phytochemical Analysis:

According to Harborne (1973), the following preliminary phytochemical analysis was performed on the crude extracts**:**

1- Detection of flavonoids

2-3 ml of the onion extract were mixed with a few drops of sodium hydroxide solution (20%) in an assay tube. When a few drops of diluted HCl were added, the vivid yellow hue that had formed as a result of the presence of flavonoids disappeared (Khandelwal, 2008).

2-Detection of glycosides:

Concentrated H_2SO_4 is added to a test tube containing 5 ml of extract, 2 ml of glacial acetic acid, and 1 drop of 5% $FeCl_3$ to produce a brown ring. This demonstrates that glycosides are present. (Khandelwal, 2008).

3- Detection of Phenol

According to Gibbs (1974), phenols can be detected by adding a half-milliliter of Fe Cl_3 (5%) solution to two milliliters of test solution.

4- Identifying of saponins

Five milliliters of the extract and 20 milliliters of distilled water should be combined to. 15 minutes are spent stirring the mixture in a graduated cylinder. Foam development indicates the presence of saponins (Kumar *et al.,* 2009).

5- Identifying of steroid

One milliliter of plant extract was mixed with ten milliliters of chloroform, and an equal volume of concentrated H_2SO_4 was added to the test tube's sidewalls. As the upper layer got red, the H_2SO_4 layer fluoresce a yellowish green color. This typically indicates the presence of steroids (Gibbs, 1974).

6- Detection of tannin

After adding 2 ml of extract to a few drops of 1% lead acetate, the presence of tannins could be seen in the brownish precipitate (Treare and Evans, 1985).

7- **Detection of terpenoids**

By mixing two milliliters of the plant extract with two milliliters of concentrated H_2SO_4 and acetic anhydride. The development of a blue-green ring is a sign that terpenoids are present (Ayoola *et al.,* 2008).

2.6. Quantitative phytochemical analysis

2.6.1. Determination of total polyphenol

Using the Folin-Ciocalteu reagent, total polyphenols (TP) were measured (Maurya and Singh, 2010). A reference gallic acid solution with a concentration between 0.01 and 0.05 mg/ ml was used to produce the calibration curve, and measurements were made at 760 nm using a UV-Vis spectrophotometer. Each analysis was carried out three times. Gallic acid served as the calibration standard, and results were expressed as milligrams of equivalent gallic acid per gramme of material.

2.6.2. Determination of total flavonoid content

The methods described by Ebrahimzadeh *et al.* (2008) were employed to assess the flavonoid content. In a nutshell, the following ingredients were combined for 30 minutes at room temperature: 1.5

ml of methanol, 0.5 ml of samples for all examined cultivars, 0.1 ml of 10% potassium acetate, and 2.8 ml of distilled water at 415 nm, the absorbance was measured using a spectrophotometer. Milligrams of quercetin equivalents (mg QE/g extract) were used to measure the data. The standard curve was created using quercetin at a range of concentrations (5–50 mg/L).

2.6.3. Determination of total antioxidant activity

Due to Brand-Williams *et al.* (1995), the antioxidant activities of the 80% methanol absolute were assessed using the discoloration of this solvent caused by the free radical 1,1 diphenyl-2-picrylhydrazyl (DPPH), which measures free radical scavenging activity. Two ml of a solution of DPPH (25 mg/L) in methanol were added, and the reaction mixture was vigorously shaken and left in the dark for 30 minutes. Two milliliters of methanol (80%) of test material at various concentrations (1-64 g/ml) were added, as well as methanol solution used as a control. The mixture's absorbance was then compared to that of pure methanol (blank) using a 517 nm T80 UV/Vis spectrophotometer.

Using the following formula, the proportion of radical scavenging activity was determined:

(A0 - A1/A0) x 100 = radical scavenging (%), where A1 is the sample extract absorbance and A0 is the control absorbance. The effective concentration of the drug is represented as the 50% inhibitory concentration value (IC50).

2.6.4. GC-MS analysis

In the mass spectrometry lab at the National Research Centre (NRC), Dokki, Giza, a Thermo Scientific TG-5MS fused silica capillary column (30 m, 0.25 mm, 0.1 mm film thickness) was utilized to conduct the GC/MS study. An electron ionization device with an ionization energy of 70 eV is employed for GC/MS detection. As the carrier gas, helium gas was utilised at a steady flow rate of 1 milliliter per minute. The MS transfer line and injector were both adjusted to 280 °C. A percent relative peak area was used to examine the quantification of each component that was found. A preliminary identification of chemicals was made based on the comparison of their respective retention times and mass spectra with those of the NIST and WILLY library data of the GC /MS system (Adams, 2007).

2.7. Statistical analysis

All obtained data were statistically analyzed according to the Analysis of Variance (ANOVA) for the Randomized Complete Block Design (RCBD) by using "MSTAT-C" computer software According to Gomez and Gomez (1984). The Duncan test method was used to test the differences between treatment means at a 5 percent level of probability.

3. Results

In respect to the many features that have been evaluated, the data overall demonstrated a considerable difference between all various cultivars. According to data in Table (2), Giza 20 c.v. provided the best values for plant height at 90 and 110 days following the planting date during the two studied seasons. It was found that Giza 6 oblong cultivar was superior all other onion cultivars at number of leaves trait after 90 days from cultivation (8.25 and 8.00) during the two tested seasons, respectively. While after 120 days it gave also the best values with a significant increase whit all tested cultivars except Giza 20 which gave nearly values at the two studied seasons (Table 2). Concerning day to maturity trait, results at Table 3 showed that Sabeeni cultivar had the shortest maturity period and required (107.50 and 108.8 days) to reach harvest in both studied seasons, in contrast, the two cultivars Giza 6 oblong and Giza 6 takes the longest growing seasons (142.00 and 141,3) and (140.5 and 141.50 days) during the two seasons respectively.

Data in Table 3 showed that the three cultivars Sabeeni, Shandweel 1 and Giza red gave the lowest value for the number of bolters (0.00) in the first season, while the lowest values of bolters in the second season were found by the two cultivars Giza 6 and Giza Red (0.00). The highest values of bolters were obtained by the two cultivars Shandweel 1 and Giza white (1.750 and 1.500) and (1.000 and 0.750) during the two seasons, respectively.

Data in Table 3 revealed that the highest values of double bulbs were recorded by the two cultivars Shandweel 1 and Giza Red (4.750 and 4.500) and (3.750 and 3.750) during both seasons, respectively. The lowest values for the previous character was showed by the Sabeeni cultivar (0.250 and 0.500) during the two seasons, respectively. Concerning TSS trait, data showed that Composit 16 and Giza 6

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Table 2: Plant height and number of leaves after 90 and 110 days from planting obtained from eight Egyptian onion cultivars during 2023 and 2024 seasons.

Cultivars	Plant height after 90 Days		Plant height after 110 Days		No. of leaves after 90 Days		No. of leaves after 110 Days	
	2023	2024	2023	2024	2023	2024	2023	2024
Giza 6	56.00 AB	58.75 B	62.00 B	65.00 BC	6.000 D	6.500 BC	7.250 D	9.500 AB
Giza 20	63.50 A	69.75 A	69.75 A	75.00 A	7.750 AB	7.500 AB	10.25 A	9.250 AB
Sabeeni	56.25 AB	50.25 C	63.25 AB	55.75 D	7.500 AB	6.750 BC	9.250 B	9.750 A
Shandweel 1	54.00 B	53.25 BC	67.25 AB	62.00BCD	6.000 D	6.750 BC	9.000 BC	9.000 B
Giza 6 oblong	58.25 AB	54.00 BC	64.50 AB	61.50BCD	8.250 A	8.000	10.25 A	9.750 A
Giza White	53.75 B	52.25 BC	62.25 B	66.50 BC	6.500 CD	6.250 C	9.500 B	9.000 B
Giza Red	61.50 AB	58.25 BC	65.75 AB	67.25 B	7.000 BC	6.250 C	9.250 B	9.000 B
Composit 16	60.00 AB	60.00 B	60.75 B	59.50 CD	6.000 D	7.000 BC	8.500 C	9.500 AB

Note: According to Duncan's Multiple Range Test (DMRT), the means of each treatment in each column that are followed by the same letter (s) are not significant at the 0.05 level of probability.

Table 3: Days of maturity, Bolters, Double bulb and TSS characters for eight Egyptian onion cultivars during 2023 and 2024 seasons.

Cultivars	Days to maturity		Bolters		Double bulb		T.S.S	
	2023	2024	2023	2024	2023	2024	2023	2024
Giza 6	127.3 C	127.8 B	0.750 BC	0.000 B	2.750 B	2.750 BC	13.00 C	13.25 C
Giza 20	140.5 B	141.3 A	0.500 BC	0.500 B	1.250 C	1.250 D	15.25 B	15.25 B
Sabeeni	107.5 F	107.8 D	0.000 C	0.500 B	0.250 C	0.500 D	13.25 C	13.50 C
Shandweel 1	119.5 D	118.8 C	1.750 A	1.500 A	4.750 A	4.500 A	13.50 C	13.75 C
Giza 6 oblong	142.0 A	141.3 A	0.000 C	0.250 B	0.750 C	1.750 CD	16.00 AB	16.25 AB
Giza White	117.5 E	118.3 C	1.000 AB	0.750 AB	1.250 C	1.000 D	15.50 AB	15.50 AB
Giza Red	118.8 DE	127.8 B	0.000 C	0.000 B	3.750 AB	3.750 AB	13.50 C	13.50 C
Composit 16	127.5 C	118.8 C	0.500 BC	0.500 B	1.000 C	0.500 D	16.50 A	16.50 A

Note: According to Duncan's Multiple Range Test (DMRT), the means of each treatment in each column that are followed by the same letter (s) are not significant at the 0.05 level of probability.

oblong cultivars gave the highest values (16.50 and 16.50) and (16.00 and 16.25) during both seasons respectively. while Giza 6 cultivar gave the lowest values in both seasons (13.00 and 13.25, respectively).

Generally, data in Table 4 showed that there were significant differences between almost studied onion cultivars during the two studied seasons. It was found that the three cultivars (Giza 6 oblong, Giza 20 and Sabeeni) gave the lowest values of total weight loss after 2, 4 and 6 months with a significant decrease with all other tested cultivars during both studied seasons. On contrast, the highest values of total weight loss were recorded in the three cultivars Shandweel 1, Giza Red and Giza 6 as compared to all other studied cultivars during both seasons.

As shown in Table 5, the highest values of the bulb weight trait during the two seasons were found by the three cultivars Giza 20 (108.5 and 108.8 g, respectively), Giza 6 (101.2 and 102.6 g, respectively) and Shandweel 1 (100.3 and 97.13 g, respectively) with a significant increment as compared to almost other studied cultivars. The lowest values of bulb weight (78.47 g and 78.90 g) were obtained by the Sabeeni cultivar during the two seasons, respectively. The highest values of total yield were found by Composit 16 (17.70 and 17.65 tons/fed.) followed by Giza 20 (17.22 and 17.58 tons/fed.) and Giza 6 oblong (17.06 and 17.14 tons/fed.) with a significant increment with all other cultivars during the both seasons, respectively. While, the lowest values was found by Shandweel 1 cultivar (14.09 and 13.93 tons/fed.) as compared to other cultivars during both seasons, respectively.

Concerning marketable yield, data in Table 5 showed that the three cultivars Composit 16 (14.51 and 14.47 tons/fed.), Giza 20 (14.12 and 14.41 tons/fed.) and Giza 6 oblong (13.99 and 14.05 tons/fed.) gave the best values of marketable yield as compared to other studied cultivars during both seasons, respectively. Finally, data showed that Shandweel 1 had the highest values of culls yield (5.72 and 5.76 kg) during both seasons ,respectively, followed by Composit 16, (3.182 and 3.173 Kg) during both seasons, respectively. While, Giza red cultivar had the lowest values (2.52 and 2.50 Kg) during both seasons, respectively. Numerous studies have been conducted on the growth, yield and chemical variation in a wide range of onion genotypes over two succeeding seasons. The data showed a sizable variation between the various genotypes. The year of growth also played an interfering role in affecting the different characteristics of growth, yield components, total yield, and phytochemical composition.

Numerous researchers in Upper Egypt discovered significant variation among onion genotypes for the majority of examined features (Gamie *et al.,* 2000; El-Damarany and Obiadalla-Ali, 2005; Gamie and Yaso, 2007; Marey and Morsy, 2010; El-Helaly and Karam, 2012). The genetic variety of the onions may be the cause of the variation in yield. According to Kasech and Rahel (2018), genotype Nafis produced the highest marketable bulb yield (36.24 t/ ha), which is consistent with this outcome. Our research, along with earlier genotypes and storage studies of onions by Peters *et al.* (1994); Obiadalla and El-Sawah (2009), indicated that the weight loss, decay, and sprouting percentages of onions vary by genotype, where the genotypes differed substantially in how sensitive it's sensitive.

3.1. Economic feasibility study

Total cost including (transportation, weeding, fertilizers, irrigation, planting, seeding, and other costs), total income, and benefit/cost in connection to the various treatments. The primary conclusions of this research indicate that the use of Composit 16 and Giza 20 cultivars provided the highest possible economic assessment values. The average total income per fed of onion yield ranged from about 8390 L.E./fed with a minimum B/C ratio of 1.56, which was recorded with Shandweel 1, to about 16550 L.E./fed with a maximum B/C ratio of 2.11, when using Compsit 16 followed by the Giza 20 genotype, which, in addition to the benefit/cost ratio, increased the total income and net return in both seasons. (Figures 2, 3 and 4). It is clear that a high bulb yield at a cheap cost maximizes revenue.

Table 4: Total weight loss of eight Egyptian onion cultivars after 2, 4 and 6 months from harvesting during 2023 and 2024 seasons.

Cultivars	Total weight loss after 2 month		Total weight loss after 4 month		Total weight loss after 6 month	
	2023	2024	2023	2024	2023	2024
Giza 6	6.940 B	6.747 B	18.82 A	18.26 B	30.22 C	30.67 B
Giza 20	2.418 E	2.043 D	9.070 D	7.230 DE	14.94 D	14.85 C
Sabeeni	4.005 D	4.150 C	10.34 D	8.925 D	15.36 D	15.17 C
Shandweel 1	9.462 A	9.368 A	19.71 A	20.43 A	44.48 A	42.96 A
Giza 6 oblong	2.115 E	2.033 D	7.300 E	6.860 E	12.17 D	11.89 C
Giza White	5.327 C	4.173 C	16.57 B	15.24 C	35.92 B	30.36 B
Giza Red	7.578 B	7.330 B	14.77 C	13.99 C	29.96 C	29.58 B
Composit 16	3.760 D	4.755 C	14.60 C	14.93 C	29.99 C	32.44 B

Note: According to Duncan's Multiple Range Test (DMRT), the means of each treatment in each column that are followed by the same letter (s) are not significant at the 0.05 level of probability.

Table 5: Bulb weight, total yield, marketable yield and culls yield traits for eight Egyptian onion cultivars during 2023 and 2024 seasons.

Cultivars	Bulb weight		Total yield		Marketable yield		Culls yield	
	2023	2024	2023	2024	2023	2024	2023	2024
Giza 6	101.2 B	102.6 B	15.53 C	15.30 C	12.73 C	12.54 C	2.790 C	2.750 C
Giza 20	108.5 A	108.8 A	17.22 B	17.58 AB	14.12 B	14.41 A	3.095 B	3.155 B
Sabeeni	78.47 D	78.97 E	15.07 D	14.21 DE	12.35 D	11.65 E	2.705 CD	2.620 DE
Shandweel 1	100.3 B	97.13 C	14.09 E	13.93 E	9.325 F	9.448 F	5.715 A	5.762 A
Giza 6 oblong	97.63 B	96.95 C	17.06 B	17.14 B	13.99 B	14.05 B	3.068 B	3.082 B
Giza White	97.32 B	90.35 D	14.69 D	14.65 D	12.04 D	12.01 D	2.638 DE	2.635 CD
Giza Red	92.25 C	92.43 D	15.05 D	15.18 C	11.55 E	11.42 E	2.527 E	2.503 E
Composit 16	90.20 C	99.57 BC	17.70 A	17.65 A	14.51 A	14.47 A	3.182 B	3.173 B

Note: According to Duncan's Multiple Range Test (DMRT), the means of each treatment in each column that are followed by the same letter (s) are not significant at the 0.05 level of probability.

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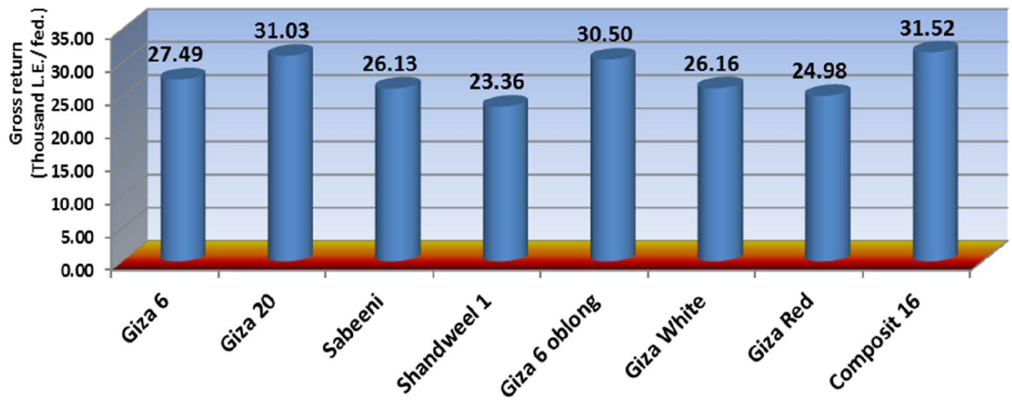

Fig. 2: Gross return (thousand L.E./ fed.) of onion yield for eight Egyptian onion cultivars as overall mean values during two growing seasons.

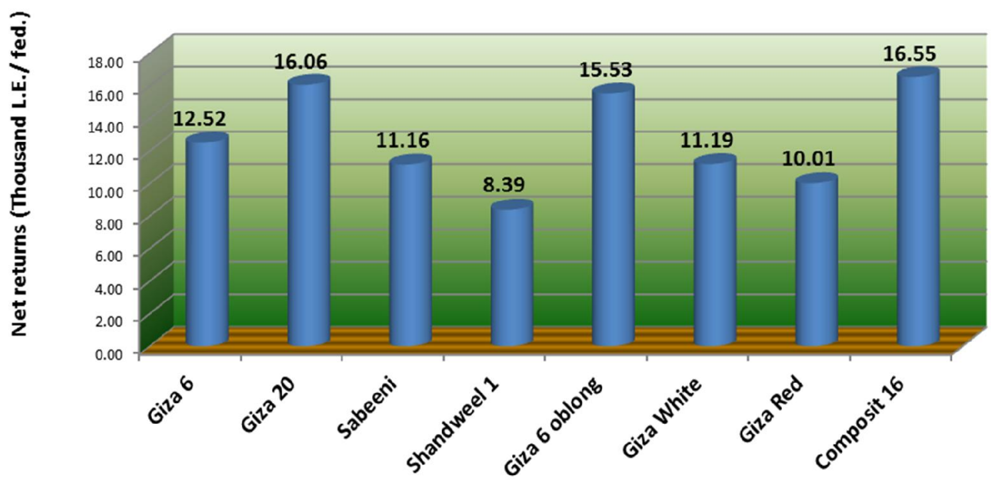

Fig. 3: Net returns (thousand L.E./ fed.) of onion yield for eight Egyptian onion cultivars as overall mean values during two growing seasons.

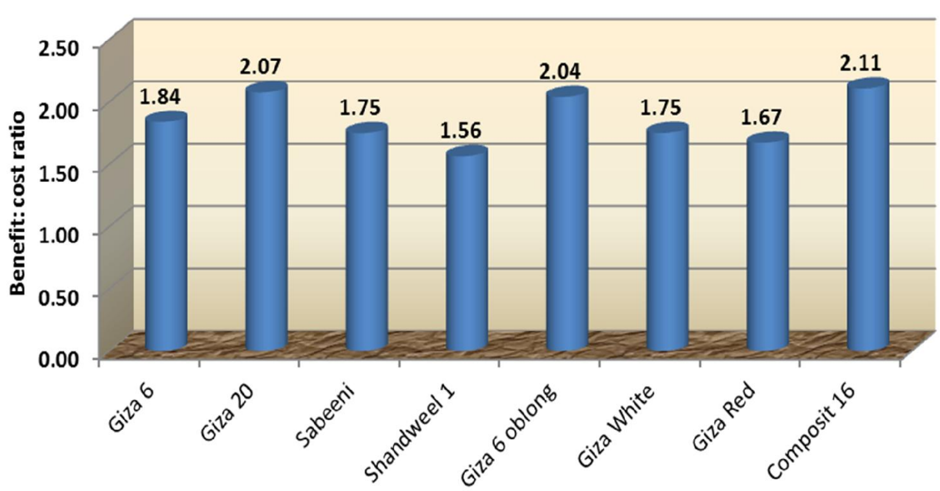

Fig. 4: Benefit: cost ratio of onion yield for eight Egyptian onion cultivars as overall mean values during two growing seasons.

3.2. A qualitative examination of phytochemicals

In every onion cultivar under study, several phytochemical components were found, including steroids, terpenoids, tannins, saponins, emodins, glycosides, flavonoides, and phenols, and the results are summarized in Table 6. The obtained results showed that all phytochemical constituents were presented in all onion cultivars except emodins which were detected only in Giza 20 cultivar and saponins which were presented only in the three cultivars Giza 6, Giza20 and Giza 6 oblong. Tannins were absent in the two cultivars Sabeeni and Composit 16. Finally, steroids were not detected in the three onion cultivars Shandweel 1, Giza White and Composit 16.

3.3. Phytochemical quantitative analysis

Total phenolic and flavonoid chemicals were measured using the equivalents of quercetin (mg of Q/g sample) and gallic acid (mg of GAE/g sample). According to the present findings (Table 7), Giza red extract contained the highest concentration of phenolic and flavonoid components (25.88 mg GAE/g and 36.58 mg QE/g, respectively). The highest DPPH scavenging activities are shown by the methanolic extract (80%) of Giza White extract (103.62 µg/ml). Flavonoids, carotenoids, and triterpenes have antioxidant properties that scavenge reactive oxygen species and shield biological components, including DNA, proteins, and lipids, from damage (Ksouri *et al.,* 2013). Antioxidants are substances that help to lower DPPH's radical state by donating an electron or hydrogen. Due to this reaction, DPPH turns yellow instead of purple (Ma *et al.,* 2018).

3.4. GC-MS Analysis

Data showed in Table 8 and Fig. 5 revealed the presence of eight phyto-compounds in Giza red onion extract, identified by GC-MS spectroscopy. The main major component was identified as n-Hexadecanoic acid with (23.39%); cis-vaccenic acid was identified as the second primary compound (11.91%) and bis (2-ethylehexyl) phthalate constituted the third component (5.47 %) in the Giza red onion extract. Also, there were other components with less than 5.47 % (Table 8).

Several phytochemicals with advantageous functions are abundant in onions, including polysaccharides (Ma *et al.,* 2018), phenolic compounds, organosulfur compounds (Moreno *et al.,* 2018; Zamri and Abd Hamid, 2019), and phenolic compounds (Lee *et al.,* 2017 and Viera *et al.,* 2017). saponins (Lanzotti *et al.,* 2012; Dahlawi *et al.,* 2020). Yellow onion was the next-highest in anthocyanins and flavonols after red onion, whereas white onion had the lowest levels (Zhang *et al.,* 2016). Additionally, various onion layers had distinct main components (Beesk *et al.,* 2010). The chemical quercetin was mostly found in the skin of red onions, whereas quercetin-4-glucoside was mostly found in their bulbs (Park *et al.,* 2018). Total phenolic content is a hereditary trait that varies greatly between genotypes. By synthesizing various amounts and/or types of phenolics, harvest location strongly affects the concentration of phenolic compounds (Pal *et al.,* 2019). Our results are in line with those of Aggarwal *et al.* (2016), who discovered the total phenolic acid concentration is greater in the red onion. An excellent natural antioxidant source is onions (Sidhu *et al.,* 2019). Numerous investigations into the antioxidant capabilities of onions have been conducted. These investigations have revealed that onions have strong antioxidant qualities when tested in a variety of in vitro assays, such as those utilizing 1,1-diphenyl-2-picrylhydrazyl (DPPH). Principal component analysis was used to separate the antioxidant activity of different red onion portions, such as edible portion and dry skin. This was likely done because the dry skin is high in quercetin and the edible portion is high in quercetin-4-glucoside (Park *et al.,* 2018).

Finally from the yield and economical point view, it could be concluded that among all studied Egyptian onion cultivars the three cultivars (Composit 16, Giza 20 and Giza 6) were the best for cultivation under experimental conditions. As well as, according to phyto-chemicals analysis Giza red cultivar was superior more than all other cultivars.

Table 6: Phytochemical screening tests for constituents of eight onions extracts.

Constituent	Giza 6	Giza 20	Sabeeni	Shandweel1	Giza6 oblong	Giza White	Giza Red	Composit 16
Steroids	++	+++	+	-	+	-	+	-
Terpenoids	+++	+	+	+	+++	++	+++	++
Tannins	++	++	-	+	+++	++	+++	-
Saponins	++	+++	-	-	+	-	-	-
Emodins	-	++	-	-	-	-	-	-
Glycosides	+++	+++	+++	+	+++	++	+++	++
Flavonoids	++	++	+	++	+	++	+++	+
Phenols	+	+	+	+	+	+	+	+

* (+++), (++), (+) and (-) refer to high, moderate, low and absent amount, respectively.

Table 7: Total phenolic compounds, total flavonoids and DPPH IC50 of *onion* extracts.

Constituent	Giza 6	Giza20	Sabeeni	Shandweel1	Giza6 oblong	Giza White	Giza Red	Composit 16
Total phenolics (mg gallic acid/g)[a]	13.38±0.4	17.60±0.8	14.75±0.3	16.10±0.20	8.875±0.12	16.20±0.3	25.88±0.37	12.58±0.42
Total flavonoids (mg quercetin /g)[b]	29.00±0.5	22.42±0.3	16.42±0.46	24.33±0.36	13.42±0.3	25.57±0.29	36.58±0.22	22.33±0.36
DPPH IC50 (µg/ml)*	54.85	47.80	74.12	98.79	70.76	103.62	47.16	56.29

a: mg GAE /g of dry leaves extract; b: mg QE/g of dry extract. Each value is expressed as the mean.± SD.*The IC_{50} values correspond to the amount of extract required to scavenge 50% of radicals present in the reaction mixture.

Table 8: The major phyto-components of Giza red cultivar extract using GC-MS analysis

NO	RT	Compound Name	Molecular Formula	Area %	MW	Nature	activity
1	22.89	TETRADECANOIC ACID	$C_{14}H_{28}O_2$	5.23	228	Fatty acid	Antimicrobial activity against against infectious microorganisms such as *C. albicans* (Choi *et al.,* 2013)
2	26.89	N-HEXADECANOIC ACID	C16H32O2	23.39	256	Fatty acid	Cancer prevention, hypocholesterolemia, anti-inflammatory, and antioxidant properties (Kalpana et al. 2012)
3	30.21	CIS-VACCENIC ACID	$C_{18}H_{34}O_2$	11.91	282	omega-7 fatty acid	antibacterial activity and hypolipidemic effect in rats (Hamazaki et al. 2016)
4	30.31	9-OCTADECENOIC ACID	$C_{18}H_{34}O_2$	4.19	282	Fatty acid	Lowering cholesterol, reducing inflammation, cancer prevention, Hepatoprotective, Insectifuge, Nematicide, Antihistaminic, and Antieczemic (Rehana and Nagarajan 2013)
5	33.71	ISOCHIAPIN B	$C_{19}H_{22}O_6$	3.03	346	Sesquiterpene lactone	its anti-insect, antimicrobial, antioxidant, and anticancer activities (García et al. 2009 and Marandi 2017)
6	36.63	BIS(2-ETHYLEHEXYL) PHTHALATE	$C_{24}H_{38}O_4$	5.47	390	organic compound	decreased apoptosis and oxidative damage (Rusyn et al. 2012)
7	40.22	FLAVONE 4'-OH,5-OH,7-DI-O-GLUCOSIDE	$C_{27}H_{30}O_{15}$	4.52	594	Flavonoids	Antioxidant activity (Jitareanu et al. 2013)
8	42.23	ETHYL ISO-ALLOCHOLATE	$C_{26}H_{44}O_5$	5.40	436	Steroid	Antimicrobial activity (Malathi et al. 2016)

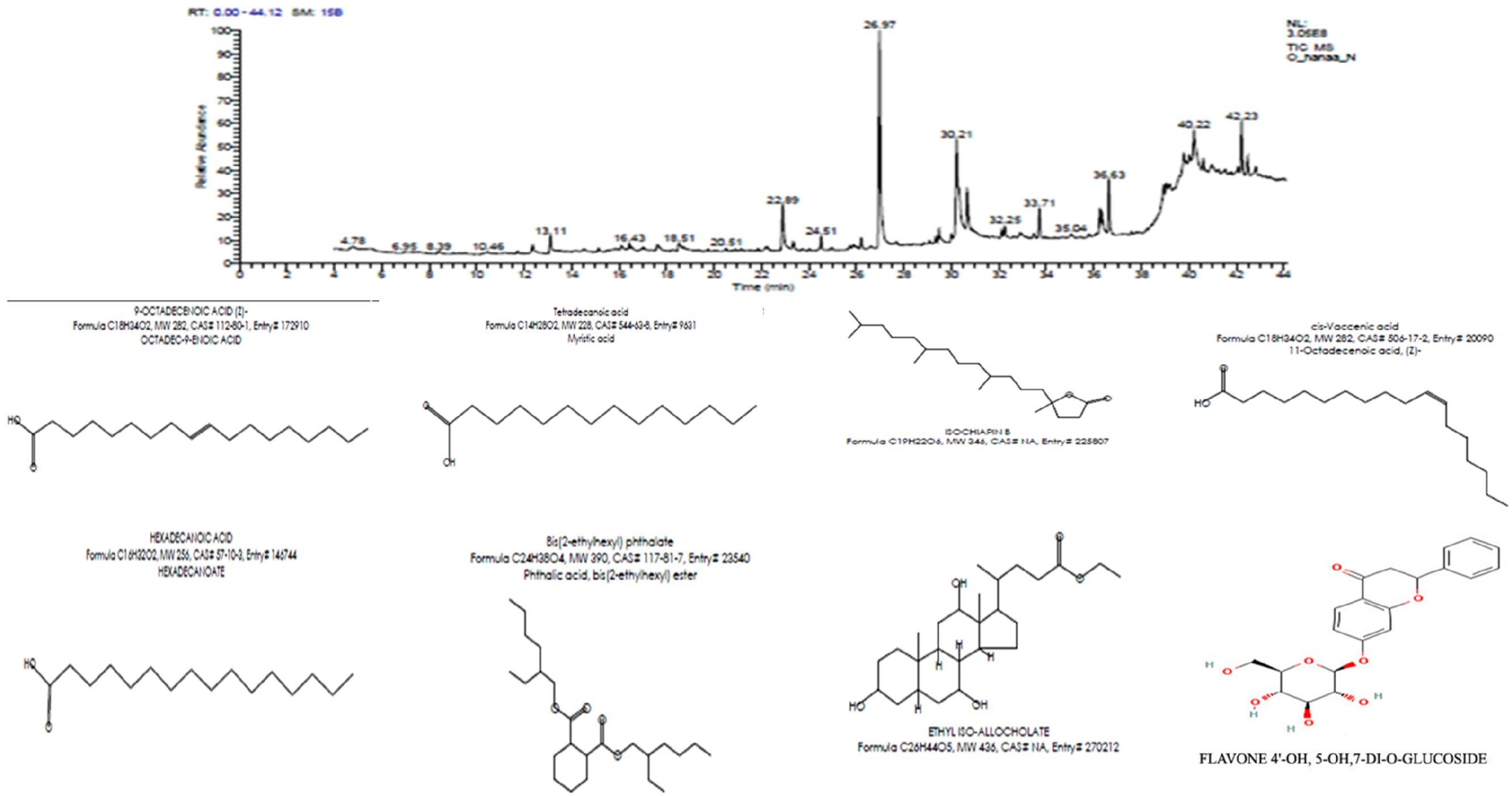

Fig. 5: GC/MS chromatogram for separation of Giza red onion extract .

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