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Physical and Biochemical Characterization of Grape Genotypes Grown Under Kandahar Province of Afghanistan for Quality Traits

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ABSTRACT

The present investigation was carried out in 2023 at Kohkaran Research Farm which established by Perennial Horticulture Development Center (PHDC), Ministry of Agriculture, Irrigation and Livestock (MAIL), based on Kandahar, Afghanistan. The treatments comprised 6 seedless genotypes and 16 seeded genotypes namely T1: Kandahari Sorkh, T2: Exotic, T3: Sahibi Sra 488, T4: Fantasy, T5: Perlette, T6: Keshmeshi Sia, T7: Tashkandi, T8: Black Emerald, T9: Aqa Ali 876, T10: Manaqa 801, T11: Lokh Shetor, T12: Shirahmadi heart, T13: Husaini, T14: Awi, T15: Lal Sia, T16: Typi, T17: Loghi, T18: Shaker, T19: Lal Katadana, T20: Mahmodi, T21: Lal Maida Dana and T22: Flame Seedless the physical characterization indicated variation in The maximum berry weight (7.10 g) and berry volume (34.00 ml) were noticed in Exotic. The presence of seeds, berry shape and colour were also varied considerably. Fantasy Seedless and Flame Seedless had no seed, Perlette, Kishmeshi Sia, Tashkandi, Black Emerald, Lal Sia had the rudimentary, and other genotypes had well developed seeds. As for as colour of berries concerned berries were grouped as Dark red (Kandahari Sorkh), blue-black (Exotic, Fantasy and Loghi), red (Sahibi Sra 488, Aqa Ali 876 and Lokh Shetor), deep red (Flame Seedless) dark red violet (Kishmeshi Sia and Lal Sia) and green yellow (Perlette, Shirahmadi Heart, Husaini, Awi, Typi and Lal Maida Dana). The berry firmness data revealed that Awi, Lal Sia, and Loghi produced soft berries whereas, Kandahari Sorkh, Fantasy, Perlette, kishmeshi Sia, Tashkandi, Black Emerald, Aqa Ali 876 and Lal Maida Dana produced medium firm berry, Exotic, Sahibi Sra 488, Lokh Shetor, Typi, and Flame Seedless recorded to have firm berries.biochemical characterization indicated variation in pH, TSS, Acidity, TSS: Acidity Ratio and Vitamin C. Among the different varieties. The maximum pH (4.50) was noted in Shirahmadi Heart followed by Husaini (4.40). The highest TSS (21.70 B°) was noticed in Lal Maida Dana, followed by Lokh Shetor (21.63 B°) and Awi (21.43 B°). The maximum titratable acidity (1.20 %) was recorded in Kishmeshi Sia whereas the minimum acidity (0.23 %) was noted in the Fantasy Seedless grape. The maximum vitamin C content (37.20 mg/100g) was recorded in Typi while the minimum vitamin C content (11.00 mg/100g) was measured in Fantasy Seedless.

Keywords- Grape, physical and biochemical, genotypes, yield and quality.

I. INTRODUCTION

Grape (Vitis vinifera L.) is one of the most nutritious, valuable and demandable remunerative fruit crops. It belongs to the family Vitaceae. Grape (Vitis sp.) is divided into two sub - genera, Euvitis Planch. (2n=38) and Muscadinia Planch. (2n=40) (Einset and Pratt, 1975). Grapevine is one of the worlds. major fruit crops and has the earliest recorded history. The *vitis vinifera* has intermittent tendrils having same origin with clusters. Flowers are born in racemose panicle opposite to

leaves on current season‟s growth. The individual flower, or floret, can be hermaphrodite, pistillate and staminate though on cultivated vines it is always perfect which allows for self–pollination. Flowers, open from the base rather than the tip, form a cap (known as calyptra), which burst at anthesis. The fruit of grape vine is a true berry and a cluster of berries on main rachis and secondary rachis are referred to as “bunches”. The color of berries ranges from greenish, purplish, golden, reddish, pink or bluish black, while the flavour range from fruity, spicy and scuppernong depending upon the cultivar.

Grapes have beneficial effects on human health and gives higher returns per unit area when grown on commercial scale. It is one of the most eaten and delicious fruits around the world. Internationally, about 23 percent of the total grapes are used for fresh consumption, while 86.6 percent of the crop is processed, especially for winemaking (Liu et al., 2006). According to FAO (2020), the global grape production was 79.13 million metric tonnes. Major quantity of grapes is generally been dried to produce Munnaka and Kishmish. Farmers dry 20 to 25% of their grape harvest for raisin production. However, the percentage of grapes dried differs greatly by region and year (Bunnel and Safi, 2013). Many farmers sell their produce as fresh grapes, but with minimal benefit because local fresh markets are saturated at the time of grape harvesting, and this greatly decreases prices (Yousufi, 2016). In spite of this, grapes are the most cultivated fruit crop as it is the most remunerative compared to the other fruit crops grown in the Afghanistan. Indigenous and exotic varieties are commonly cultivated in Afghanistan basically for table and raisin purpose. Indigenous varieties include Hussaini, Taifi, Kasendra, Lal, Kata, Gholafan, Red Kandahari, Red Raucha, Green Raucha, Shondakhanai, Keshmeshi, Black Keshmeshi, Kandahari sorkh, Ayta, Lal Sorkh, Cheshi Gao, Sahibi, Sherahmadi, Tandyan, Gerdak, Toran and Mer Ahmadi. The major exotic varieties which are imported from USA doing well include Flame Seedless, Black Emerald, Red Globe, Crimson Seedless, Cardinal, Ribier and Perlette. The quality of grapes depends on both biotic as well as abiotic factors. Both biotic and abiotic factors greatly affect the internal and external quality of grape berry (Winkler et al., 1974; Ahmed et al., 2004 a & b) of which climatic parameters accounts for the variation in vine yield and quality. The variability with regards to 3 fruit quality seems promising for identification of variable hybrids for fresh consumption and processing purposes. Jackson and Lombard (1993) also categorically emphasized that the climate plays a decisive role during berry growth and development particularly for berry maturity, ripening, physico – chemical traits of the berry quality including shape, size, color, taste, and aroma and anthocyanins accumulation. As per the investigation of Poudel et al. (2010) grape passes through different growth stages like veraison stage, growth phase, 50 % bloom, berry set, maturation, ripening, leaf fall and dormancy, during each production year. The different growing conditions, varieties and locations also significantly influence the grape maturity and the time of harvest. This is mainly due to the genotypic adaptability to the varied climatic conditions (Cameron and Pasqual, 2004). Grapes are now a very famous because of nutraceutical properties. Antioxidants provide defense mechanism against free radical damage and are therefore, important for maintaining optimum health. A large number of processed products are being made from grape juice, oil, and wine which supply antioxidants in the form for phenols, flavonoids, and anthocyanins (Leifert and Abeywardena, 2008; Marki et al., 2008; Palomino et al., 2000). These are generally classified as bioactive compounds. These constituents are mainly polyphenols, categorized into two major groups namely, non-flavonoids (hydroxylbenzoic, hydroxycinnamic acids, stilbenes) and flavonoids (anthocyanins, flavan-3-ols and flavonols). The red, purple, and black grapes are the rich source of dietary anthocyanins are used in food items. The anthocyanins are lacking in white grapes. The predominant anthocyanins present in grape skins includes cyanidin, delphinidin, malvidin, peonidin, peonidin and petunidin (Wrolstad, 2000). Malvidin, the major anthocyanin responsible for reddest fruit, and cynidinis responsible for purple coloration. Besides very rich nutritionally, grapes are the most popular and delicious fruits, and rich source of vitamins and minerals. The most important carbohydrates in terms of quantity are glucose, fructose and sucrose as they taken together account for around 95% of total sugar quantity. The most important organic acids, on the other hand, are tartaric acid, malic acid and 4 citric acid that supply must and subsequent wine with their respective freshness. Sucrose is hydrolyzed into fructose and glucose in berries, and their resultant concentration is in relation to that of fructose higher in the berries‟ first phase of growth and maturation. Fructose is on average twice sweeter as compared to glucose, and the ratio of both sugars also depends on the genetic potential of grapevine varieties (Rusjan Denis and korosc-koruza, 2006).

II. MATERIALS AND METHODS

The present investigation entitled biochemical characterization of grape genotypes grown under Kandahar Province of Afghanistan for quality traits was carried out during on 2023 at Kohkaran Research Farm which established by Perennial Horticulture Development Center (PHDC), Ministry of Agriculture, Irrigation and Livestock (MAIL), based on Kandahar, Afghanistan. The materials, methods, metrological conditions, and experimental site adopted during the research program have been explained in detail in this chapter under the following subtitles.

Soil characteristics of the experimental site

To know about physico–chemical characteristics of the soil during the year of study, soil samples were taken from 0 – 50 cm depth at various spots of the experimental field. A representative composite samples was prepared by mixing them together and the sample was analyzed for physical and chemical properties. The result of analysis, stated in table 3.2, showed that the soil was sandy loam with texture, sand (67.6%), silt (26 %), clay (6.4%), and with moderate drainage as

well distinguished as alluvial deposit but the fertility is moderate with a pH of 8.32 and an electrical conductivity [EC; 1.2 mmhos/cm].

Table: Physical and chemical composition and properties of soil

S. No.	Particulars	Value obtained
Physical characteristics		
1	Soil classification	Sandy loam
2	Sand %	67.6%
3	Silt %	26 %
4	Clay%	6.4%
5	Soil drainage	Moderately drainage
6	Soil matrix color	Hue 10 Yr = 3/3
7	Soil fertility	Moderate
8	Soil parental material	Alluvial deposit
Chemical properties		
1	Soil pH	8.32
2	Electrical conductivity	1.2 mmhos/cm

Table: Grape genotypes and categories used in the study

Sr. No	Seedless genotypes	Sr. No	Seeded genotypes
1	Keshmeshi Sia	1	Kandahari Surkh
2	Flame Seedless	2	Lal Katadana
3	Fantasy	3	Lal Sia
4	Perlette	4	Sherahmadi Heart
5	Tashkandi	5	Loghi
6	Black Emerald	6	Sahibi Sra 488
		7	Shaker
		8	Typi
		9	Awi
		10	Exotic
		11	Manaqa 801
		12	Aqa Ali 876
		13	Husaini
		14	Lokh Shetor
		15	Mahmodi
		16	Lal Maida Dana

Experimental Details

The experiment was laid out at the main orchard of Kohkaran Research Center situated in 6th Zone of Kandahar province of Afghanistan. The details of experiment given bellow.

Location: Kohkaran Research Farm, 6th Zone, Kandahar Province, Afghanistan
Crop: Grape
Number of genotypes: 22
Number of vines selected per genotype: 5
Total number of vines: 110
Spacing: 2 m x 3m
Training system: Trellis

Harvesting and sampling of grape samples

Five uniform and fully matured grapevines were selected and tagged for each genotype. Ripened bunches were randomly harvested from individual grapevines. After sorting out, bunches were packed in plastic crates and subsequently transported to laboratory for recording observation on horticultural traits (morpho-physical) analysis. Bunches were immediately kept in ambient condition in laboratory. On the same day the biochemical parameters and other parameters like, TSS, acidity, ascorbic acid, juice percentage and pH etc. were recorded.

Sample Preparation

Uniform grapevines bunches and berries devoid of any injuries were sorted out and utilized for experiment. Ten identical bunches from each variety were taken for recording physical and biochemical parameters while five bunches were selected for berries parameters. For evaluation of biochemical content 100 grams of berries were remove from a

single randomly selected bunch in each variety of grapevines. The fresh homogeneous suspension was used for ascorbic acid, TSS, juice percentage, PH, and acidity estimation. Physical parameters were analyzed from whole intact fruit.

Physical Parameters

Berry weight: In each bunch two berries were randomly selected at shoulder (top) and bottom parts of the bunches, then the total ten berries were weight individually for each variety and weight was determine by using the electronic precision balance (Aslor and AND HT-500) in gram (g).

Berry length: The sampled five bunch from each variety was harvested and selected randomly, two berries per bunch at top and bottom part of the bunch were selected and measured berry length. Berry length was determined in millimeter (mm) by using of Digimatic caliper (Mitutoyo, Japan)

Berry width: The two berries from selected five bunches were unintentionally selected at top and bottom parts of bunch and berry width were measured in millimeter (mm) by using of Digimatic caliper (Mitutoyo, Japan).

Berry shape: For recognition and exploration of berry shape, a panel of five judges were selected and based on their visual observation berry shape was decided as per descriptor and recorded.

Presence or absence of seeds: Presence of seeds in berries was observed by cutting the berries vertically and horizontally through a sharp knife and presence of seeds recorded.

Berry skin color: For analyzing the quality traits of the grapes, berry skin colour is one of the most critical parameters being used. There are six groups namely- green yellow, rose, red, red grey, dark red violet and blue black based on the descriptors of grapes provided by the International Plant Genetic Resources Institute (now Bioversity International).

Berry pulp Colour: Berry pulp Colour was recorded by visual observation.

Berry volume (CC): The five sampled berries were unintentionally selected at top, medium and bottom parts of the bunch and was picked with pedicel. Subsequently all berries were put into a water filled beaker to measure the water which spill out from beaker, measured bowl was fixed under the beaker, The water pour down into the bowl was measured by using measuring cylinder and record the berry volume in (CC).

Juice percentage: Percentage berry juice was determined by weighing 100 gram of berries without pedicel And thereafter, these berries were crushed and squeezed using cheesecloth The extracted juice was collected and weighed the juice on (Aslor and AND HT-500) balance. It gives the juice percentage.

Bunch volume (CC): The bunch was put directly into 1000 ml water filled beaker and measured bowl was fix under the beaker. The water which shed out from the beaker into bowl was measured by using measuring cylinder and records the bunch volume in CC.

Yield per vine: The bunches were counted per vine. The individual bunch weight was recorded and multiplied with number of bunches to calculate yield in terms of kg per vine.

Biochemical parameters

Total soluble solids: The total soluble solids (TSS) of grape juice were measured with the help of digital refractometer (ATAGO, TOKYO). One drop of extracted juice from each sample was placed on dry refractometer prism and readings were recorded in "Brix". The refractometer was cleaned with double distilled water after each observation. Data was expressed as equivalent degree Brix.

pH: The digital pH meter was used to measure the pH of juice extracted from each sample. The pH meter was calibrated before taking the observations with buffer solution of known pH viz., 4.00, 7.00 and 9.00. The pH of the juice was measured by dipping the electrode inside the juice sample for a few second till the stabilized pH reading was obtained. Before each observation, the electrodes of the pH meter were washed with double distilled water to wipe, clean, and remove the residual effect.

Total titratable acidity: The titratable acidity of the juice present in all the samples was determined by titration against 0.1N NaOH solution using 1-2 drops of phenolphthalein as an indicator. The 10 ml sample of the juice was used for analytical work and total volume was made up to 100 ml with distilled water and was filtered through Whatman no. 1 filter paper. Out of it 10 ml of aliquot was drawn for titration. The titratable acidity of sample was expressed as per cent tartaric acid (AOAC, 2000). The titratable acidity (%) was calculated and expressed in terms of anhydrous tartaric acid using the following formula:

$$Total\ Acidity\ (\%) = \frac{Titre \times Normality\ of\ alkali \times volume\ made\ up \times equivalent\ weight\ of\ acid \times 100}{volume\ of\ sample\ taken\ for\ estimation \times volume\ of\ sample\ taken}$$

Ascorbic acid (Vitamin C): The content of the ascorbic acid was analyzed by titration method. Dye of 2, 6-dichlorophenol indophenol used along with metaphosphoric acid as a stabilizing agent. The 10 ml sample was taken from the juice extracted from each sample which were mixed with 3% Metaphosphoric acid solution to make volume of 100 ml. From this solution, a 10 ml of aliquot was drawn and titrated against dye solution. The dye factor was calculated by titrating standard ascorbic acid solution with dye and ascorbic acid content. The end point was recorded when pink color persists for 15 seconds. The content of the ascorbic acid was calculated in mg/100 ml of juice (AOAC, 2000).

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$$Ascorbic\ acid\ (mg/100gr) = \frac{Titre\ \times Day\ factor \times volume\ made\ up \times 100}{Sample\ taken\ \times volume\ taken\ for\ estimation}$$

Statistical analysis

The experiment was conducted in RBD (Randomized Block Design) and data were analyzed using univariate ANOVA (Analysis of variances). The means were compared using LSD (Least significant differences). The SAS software utilized for the statistical analysis of the data. The differences were considered as statistically significant only when the *p*-value was lesser than 0.05 ($p \leq 0.05$).

III. EXPERIMENTAL RESULTS

The experimental findings of the study titled "physical and biochemical characterization of grape genotypes grown under Kandahar Province of Afghanistan for quality traits" are described in this article under different heads and subheads.

Brunch Physical Characteristics

Sl No.	Varieties	Bunch Length (cm)	Bunch Width (cm)	Bunch Weight (g)	Bunch Volume (ml)	Bunch Density
1	Kandahari Sorkh	18.90^{f}	12.50^{fg}	296.70^{hi}	330.00^{jk}	Medium dense
2	Exotic	21.00^{e}	10.10^{k}	188.10^{l}	335.00^{jk}	Loose
3	Sahibi Sra 488	18.50^{fg}	11.30^{j}	380.00^{e}	425.00^{fg}	Medium dense
4	Fantasy	21.70^{de}	16.50^{a}	229.90^{k}	410.00^{g}	Loose
5	Perlette	11.60^{k}	11.60^{ij}	163.50^{m}	320.00^{k}	Loose
6	kishmeshi Sia	22.20^{cd}	10.20^{k}	129.20^{n}	260.00^{l}	Loose
7	Tashkandi	22.00^{cd}	13.70^{bc}	252.10^{j}	255.00^{l}	Medium dense
8	Black Emerald	21.50^{de}	7.80^{n}	301.40^{h}	420.00^{fg}	Medium dense
9	Aqa Ali 876	16.10^{i}	11.90^{hi}	261.60^{j}	430.00^{f}	Loose
10	Manaqa 801	21.10^{e}	11.20^{j}	439.10^{c}	590.00^{b}	Medium dense
11	Lokh Shetor	20.90^{e}	13.80^{b}	522.60^{a}	520.00^{c}	Loose
12	Shirahmadi Heart	22.30^{cd}	13.30^{cd}	290.30^{hi}	360.00^{h}	Medium dense
13	Husaini	23.70^{b}	11.50^{ij}	412.30^{d}	470.00^{e}	Loose
14	Awi	18.70^{f}	13.20^{de}	336.40^{g}	355.00^{hi}	Dense
15	Lal Sia	12.60^{j}	8.60^{m}	137.50^{n}	420.00^{fg}	Dense
16	Typi	26.00^{a}	12.80^{ef}	456.10^{b}	620.00^{a}	Loose
17	Loghi	22.70^{c}	12.40^{fg}	521.10^{a}	500.00^{d}	Dense
18	Shaker	17.70^{gh}	10.50^{k}	360.40^{f}	510.00^{cd}	Dense
19	Lal Katadana	22.60^{c}	8.90^{lm}	352.50^{fg}	340.00^{ij}	Medium dense
20	Mahmodi	21.70^{de}	12.20^{gh}	284.30^{i}	270.00^{l}	Loose
21	Lal Maida Dana	17.40^{h}	8.00^{n}	164.60^{m}	320.00^{k}	Loose
22	Flame Seedless	21.70^{de}	9.20^{l}	288.60^{hi}	330.00^{jk}	Loose
23	General Mean	20.12	11.42	307.65	399.55	-
24	LSD at 5%	0.81	0.45	16.77	17.86	-

Berry length (mm): The data about the genotypic variation for berry length is given in Table From Table it is evident that there was a significant difference in the berry length of different genotypes of grapes. The maximum berry length was recorded for cv. Lokh Shetor (23.50 mm), followed by Husaini (23.50 mm) and Manaqa 801 (22.90 mm). The minimum berry length was noted in Perlette (9.60 mm).

Berry width (mm): A significant variation was found for the berry width among the different grapevine genotypes (Table 4.2). The highest width of berry was recorded for Manaqa 801 (17.40 mm) followed by Loghi (17.40 mm), Sahibi Sra 488 (17.20 mm), Lokh Shetor (17.10 mm), Typi (17.00 mm), Shirahmadi Heart (17.00 mm), Kandahari Sorkh (16.80 mm) and Shaker (16.80 mm). The minimum berry width was noticed in Perlette (8.90 mm).

Length to width ratio (berry shape index): A statistically significant difference was found for berry shape index for different grape genotypes under study. The maximum length to width ratio (1.70) was recorded in Husaini whereas, the minimum length to width ratio (1.03) was noted in Flame Seedless. The data is presented in Table

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Berry weight (g): The data presented in Table 4.2 show the significant genotypic variation in the berry weight. The maximum berry weight (7.10 g) was noticed in cv. Exotic and the minimum berry weight (0.91 g) was recorded in cv. Lal Sia.

Berry volume (ml) per 5 berries: The data revealed that the variation in berry volume was statistically significant. The maximum berry volume (34.00 ml) was noted in exotic varieties. Whereas the minimum berry volume (8.00 ml) was recorded in Kishmeshi Sia and Tashkandi, which are presented in Table

Table of Berry physical characteristics

Sl No.	Varieties	Berry length (mm)	Berry (mm)	width	Length to width ratio (Berry Shape Index)	Berry weight (g)	Berry volume (ml) per 5 berries
1	Kandahari Sorkh	19.80^{cd}	16.80^{a}		1.18^{gh}	3.95^{e}	15.00^{k}
2	Exotic	15.90^{gh}	15.30^{bc}		1.04^{kl}	7.10^{a}	34.00^{a}
3	Sahibi Sra 488	20.80^{b}	17.20^{a}		1.21^{fg}	3.60^{fg}	17.00^{i}
4	Fantasy	18.20^{e}	14.70^{c}		1.24^{f}	4.70^{c}	14.00^{l}
5	Perlette	9.60^{k}	8.90^{h}		1.08^{ik}	1.70^{m}	11.00^{m}
6	kishmeshi Sia	14.30^{i}	9.60^{h}		1.49^{b}	1.90^{l}	8.00^{n}
7	Tashkandi	15.60^{h}	11.50^{f}		1.36^{de}	1.85^{lm}	8.00^{n}
8	Black Emerald	14.60^{i}	13.60^{d}		1.07^{jkl}	1.95^{kl}	13.50^{l}
9	Aqa Ali 876	17.20^{f}	12.40^{e}		1.39^{d}	3.10^{h}	16.00^{j}
10	Manaqa 801	22.90^{a}	17.40^{a}		1.32^{e}	5.40^{b}	30.00^{b}
11	Lokh Shetor	23.50^{a}	17.10^{a}		1.37^{d}	5.35^{b}	28.00^{c}
12	Shirahmadi Heart	19.50^{cd}	17.00^{a}		1.15^{hi}	3.70^{f}	22.00^{f}
13	Husaini	23.50^{a}	13.80^{d}		1.70^{a}	5.30^{b}	19.00^{g}
14	Awi	16.30^{gh}	14.70^{c}		1.11^{ij}	2.90^{i}	15.00^{k}
15	Lal Sia	11.50^{j}	10.40^{g}		1.11^{ij}	0.91^{n}	22.00^{f}
16	Typi	19.80^{cd}	17.00^{a}		1.16^{gh}	4.20^{d}	24.00^{e}
17	Loghi	19.90^{c}	17.40^{a}		1.14^{hi}	4.30^{d}	25.00^{d}
18	Shaker	19.50^{cd}	16.80^{a}		1.16^{h}	5.30^{b}	18.00^{h}
19	Lal Katadana	16.50^{fg}	15.90^{b}		1.04^{kl}	2.86^{i}	18.00^{h}
20	Mahmodi	16.40^{g}	15.40^{bc}		1.06^{jkl}	2.43^{j}	17.00^{i}
21	Lal Maida Dana	19.10^{d}	13.30^{d}		1.44^{e}	3.50^{g}	16.00^{j}
22	Flame Seedless	14.00^{i}	13.60^{d}		1.03^{l}	2.13^{k}	22.00^{f}
	General Mean	17.65	14.54		1.22	3.55	18.75
	LSD at 5%	0.76	0.72		0.04	0.19	0.78

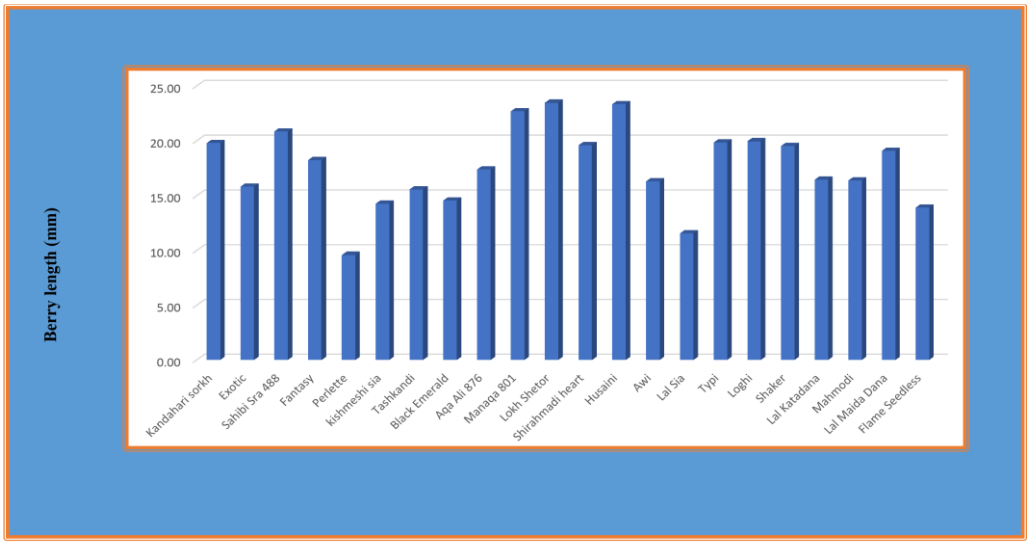

Fig. 4.1 Berry length of different genotypes

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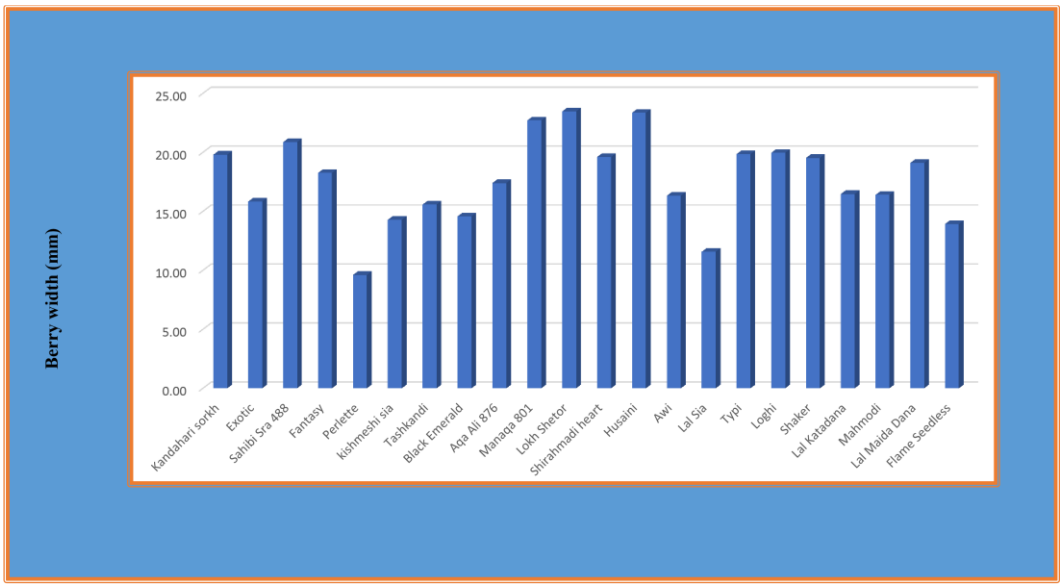

Fig. 4.2 Berry width of different genotypes

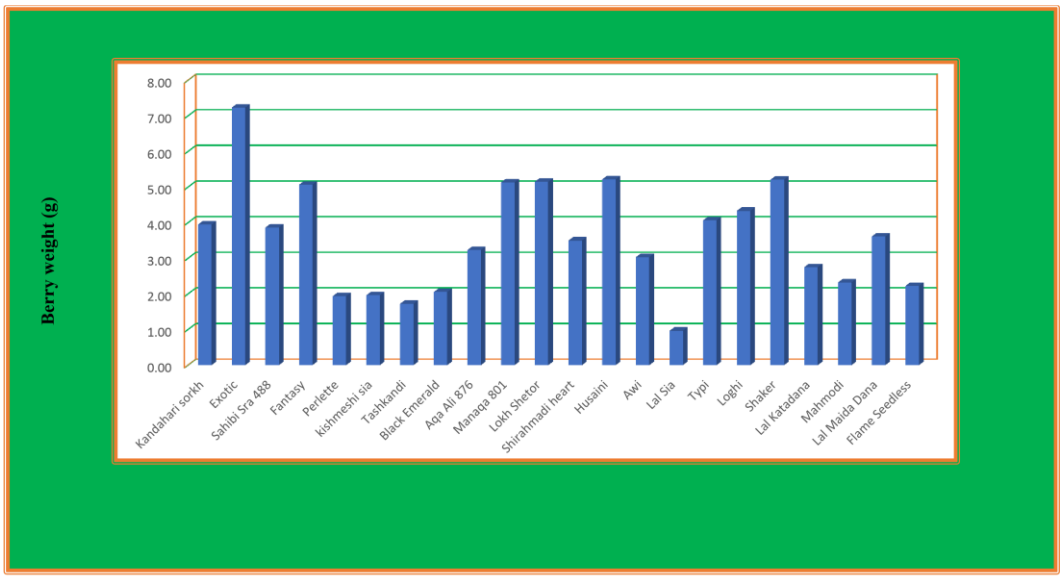

Fig. 4.3 Berry weight of different genotypes

Berry shape: The data recorded on the berry shape is affected by different varieties of grapevine and is presented in Table 4.3. There were differences found in berry shapes for all the varieties. The varieties Kandahari Sorkh, Exotic, Perlette, kishmeshi Sia, Black Emerald, Shirahmadi Heart, Awi, Lal Sia, Loghi, Lal Katadana, Mahmodi, Lal Maida Dana, and Flame Seedless were given round shape, while the Sahibi Sra 488 and Shaker were grouped as elliptic shape, Fantasy, Manaqa 801, Lokh Shetor and Husaini were recorded as narrow elliptic shape, Tashkandi noted as ovate shape, Aqa Ali 876 and Typi given obtus ovate shape.

Presence of seeds: The data presented in Tables 4.3 revealed that among all the varieties, the seeds were well developed in genotypes such as Kandahari Sorkh, Exotic, Sahibi Sra 488, Aqa Ali 876, Manaqa 801, Lokh Shetor, Shirahmadi Heart, Husaini, Awi, Typi, Loghi, Shaker, Lal Katadana, Mahmodi, and Lal Maida Dana, while, in genotypes such as Fantasy, berries were Seedless, in Perlette, Kishmeshi Sia, Tashkandi, Black Emerald and Lal Sia, seeds were rudimentary and the seeds were absent in Flame Seedless.

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Berry peel colour: The data observed from Table 4.3 show that among all the varieties, Kandahari Sorkh has dark red color, Exotic, Fantasy and Loghi are determined to be having blue-black color, Sahibi Sra 488, Aqa Ali 876 and Lokh Shetor have red color, Perlette, Shirahmadi Heart, Husaini, Awi, Typi, Shaker, Lal Katadana, Mahmodi, and Lal Maida Dana were recorded to have a green-yellow color, Kishmeshi Sia, Tashkandi, Black Emerald, Manaqa 801 and Lal Sia have dark red violet color and Flame Seedless berries have deep red color.
Berry pulp colour: The data in Table 4.3 show that genotypes such as Kandahari Sorkh, Fantasy, Perlette, Tashkandi, Aqa Ali 876, Shirahmadi Heart, Husaini, Awi, Typi, Shaker, Lal Katadana, Mahmodi, Lal Maida Dana, Flame Seedless, Sahibi Sra 488, kishmeshi Sia, Manaqa 801, Lokh Shetor and Lal Sia were recorded with weak pulp color, Black Emerald and Loghi have medium pulp color. Another genotype Exotic was recorded with strong pulp color,
Berry firmness: The data revealed from Table 4.3 that among all the grape genotypes under the study, the genotypes such as Awi, Lal Sia, and Loghi were recorded to have soft berry characteristics, whereas, Kandahari Sorkh, Fantasy, Perlette, kishmeshi Sia, Tashkandi, Black Emerald, Aqa Ali 876, Manaqa 801, Shirahmadi Heart, Husaini, Shaker, Lal Katadana, Mahmodi, and Lal Maida Dana were recorded to have medium firm berry and Exotic, Sahibi Sra 488, Lokh Shetor, Typi, and Flame Seedless recorded to have firm berry.

Table of Berry physical characteristics based on IPGRI descriptors

Sl No.	Varieties	Berry Shape	Presence of Seeds	Berry Peel Colour	Berry Pulp Colour	Berry Firmness
1	Kandahari Sorkh	Round	Well developed	Dark red	Absence or weak	Medium
2	Exotic	Round	Well developed	Blue black	Strong	Firm
3	Sahibi Sra 488	Elliptic	Well developed	Red	Weak	Firm
4	Fantasy	Narrow elliptic	Seed less	Blue black	Absent or weak	Medium
5	Perlette	Round	Rudimentary	Green yellow	Absence or weak	Medium
6	kishmeshi Sia	Round	Rudimentary	Dark red violet	Weak	Medium
7	Tashkandi	Ovate	Rudimentary	Dark red violet	Absence or weak	Medium
8	Black Emerald	Round	Rudimentary	Dark red violet	Medium	Medium
9	Aqa Ali 876	Obtus ovate	Well developed	Red	Absence or weak	Medium
10	Manaqa 801	Narrow elliptic	Well developed	Dark red violet	Weak	Medium
11	Lokh Shetor	Narrow elliptic	Well developed	Red	Weak	Firm
12	Shirahmadi Heart	Round	Well developed	Green yellow	Absence or weak	Medium
13	Husaini	Narrow elliptic	Well developed	Green yellow	Absence or weak	Medium
14	Awi	Round	Well developed	Green yellow	Absence or weak	Soft
15	Lal Sia	Round	Rudimentary	Dark red violet	Weak	Soft
16	Typi	Obtuse ovate	Well developed	Green yellow	Absence or weak	Firm
17	Loghi	Round	Well developed	Blue black	Medium	Soft
18	Shaker	Elliptic	Well developed	Green yellow	Absence or weak	Medium
19	Lal Katadana	Round	Well developed	Green yellow	Absence or weak	Medium
20	Mahmodi	Round	Well developed	Green yellow	Absence or weak	Medium
21	Lal Maida Dana	Round	Well developed	Green yellow	Absence or weak	Medium
22	Flame Seedless	Round	Absent	Deep red	Absent or weak	Firm
	General Mean	-	-	-	-	-
	LSD at 5%	-	-	-	-	-

Berry biochemical parameters
pH: The data revealed that the variation in pH was observed significantly in grape genotypes and is presented in Table 4.3. The experimental finding shows that maximum pH (4.50) was noted in Shirahmadi Heart followed by Husaini (4.40). Similarly, minimum pH (3.50) was recorded in Black Emerald.

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TSS (˚B): The results pertaining to the variations in the TSS content of grape berries were found to be statistically significant and are depicted in Table 4.3. The maximum TSS (21.70 B˚) was noticed in Lal Maida Dana, followed by Lokh Shetor (21.63 B˚), Awi (21.43 B˚), Fantasy (21.40 B˚), Shirahmadi Heart (21.23 B˚), Kandahari Sorkh (21.17 B˚), kishmeshi Sia (20.97 B˚), Perlette (20.37 B˚), Tashkandi (19.77 B˚) and Mahmodi (19.60 B˚). The minimum TSS (14.07 B˚) was recorded in grapevine genotype cv. Exotic.

Acidity (%): The data on acidity was significant in different varieties of grapevine, which is presented in Table 4.4. The result revealed from the table that maximum titratable acidity (1.20 %) was recorded in Kishmeshi Sia whereas the minimum acidity (0.23 %) was noted in the Fantasy variety of grapevine.

TSS/ Acidity Ratio: The data on the TSS/ acidity ratio of grapevine was significant, which is presented in Table 4.4. The experimental finding shows that the maximum TSS/ acidity ratio (95.11) was noticed in the Fantasy variety. While minimum TSS/ acidity ratio (17.47) was noted in the Kishmeshi Sia variety of grapevine.

Vitamin C (mg/100g): The data revealed from Table 4.4 that the variation in the vitamin C content was significant in different grapevine genotypes. The maximum vitamin C content (37.20 mg/100g) was recorded in Typi while the minimum vitamin C content (11.00 mg/100g) was measured in grapevine cv. Fantasy.

Table of Berry Biochemical Characteristic

Sl. No.	Varieties	pH	TSS (˚B)	Acidity (%)	TSS/ Acidity Ratio	Vitamin C(mg/100g)
1	Kandahari Sorkh	4.30^{bc}	21.17^{ab}	0.60^{e}	35.28^{i}	13.00^{j}
2	Exotic	4.00^{ef}	14.07^{g}	0.53^{f}	26.79^{l}	27.00^{c}
3	Sahibi Sra 488	3.90^{fg}	17.93^{ef}	0.45^{g}	39.85^{g}	31.00^{b}
4	Fantasy	3.90^{fg}	21.40^{ab}	0.23^{k}	95.11^{a}	11.00^{k}
5	Perlette	3.70^{hi}	20.37^{abcd}	0.52^{f}	39.17^{gh}	23.10^{f}
6	kishmeshi Sia	3.70^{hi}	20.97^{abc}	1.20^{a}	17.47^{n}	25.90^{d}
7	Tashkandi	3.70^{hi}	19.77abcde	0.52^{f}	38.01^{gh}	15.30^{i}
8	Black Emerald	3.50^{j}	17.63^{ef}	0.45^{g}	39.19^{gh}	12.00^{jk}
9	Aqa Ali 876	4.00^{ef}	18.43^{def}	0.53^{f}	35.11^{i}	21.00^{g}
10	Manaqa 801	3.90^{fg}	18.87^{cdef}	0.25^{j}	75.47^{b}	25.00^{de}
11	Lokh Shetor	4.20^{cd}	21.63^{a}	0.35^{h}	61.81^{d}	21.00^{g}
12	Shirahmadi Heart	4.50^{a}	21.23^{ab}	0.37^{h}	57.39^{e}	18.00^{h}
13	Husaini	4.40^{ab}	18.03^{ef}	0.30^{i}	60.11^{d}	24.00^{ef}
14	Awi	3.90^{fg}	21.43^{ab}	0.60^{e}	35.72^{i}	18.00^{h}
15	Lal Sia	3.70^{hi}	19.27bcdef	0.67^{d}	28.76^{k}	24.60^{e}
16	Typi	3.80^{gh}	17.10^{f}	0.52^{f}	32.88^{j}	37.20^{a}
17	Loghi	3.70^{hi}	18.67^{def}	1.00^{b}	18.67^{n}	21.70^{g}
18	Shaker	4.10^{de}	18.30^{def}	0.75^{c}	24.40^{m}	21.00^{g}
19	Lal Katadana	4.10^{de}	18.20^{def}	0.37^{h}	49.19^{f}	27.00^{c}
20	Mahmodi	3.80^{gh}	19.60abcde	0.52^{f}	37.69^{h}	30.00^{b}
21	Lal Maida Dana	3.80^{gh}	21.70^{a}	0.30^{i}	72.33^{c}	21.70^{g}
22	Flame Seedless	3.60^{ij}	17.60^{ef}	0.67^{d}	26.07^{lm}	15.80^{i}
	General Mean	3.92	19.24	0.53	43.02	22.01
	LSD at 5%	0.15	2.17	0.02	1.94	1.06

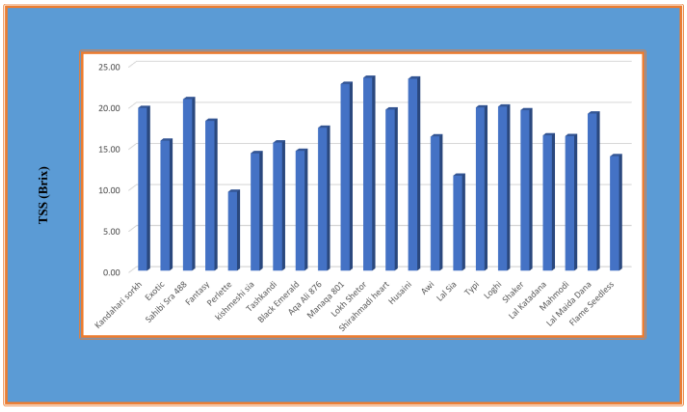

Fig. 4.4 Berry TSS in different genotypes

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IV. RESULTS AND DISCUSSION

Grapevine (*Vitis vinifera* L.) is one of the most widely cultivated species of agricultural interest (Vivier and Pretorius, 2002), spread from Central Asia to the Mediterranean Basin (Zohary and Hopf, 2000). Two subspecies, V. vinifera L. subsp. sylvestris (Gmel.) Hegi and V. vinifera L. subsp. sativa (DC.) Hegi, are considered to co-exist. The two subspecies show differences in several phenotypic traits, one of the most distinctive traits is the flower sex (Zohary, 1995; De Lorenzis et al., 2015). The domestication of wild grapes was started in the Neolithic Age, about 8000 years ago, as a result of a long and gradual process closely linked to winemaking This et al., 2006a; Forni, 2012). Grape (*V. vinifera*) is an economically important and widely cultivated fruit crop in the world and is the first fruit crop to be cultivated by man to produce table fruits, dry fruits, juice, and wine. It is a fairly good source of minerals like calcium, phosphorus, iron, and vitamins like B1 and B2 (Frederique et al., 2010; De Lorenzis et al., 2015). Grape quality is both created and determined by biochemical parameters such as total soluble solids, organic acids, and phenolic substances (Winkler et al., 1974; Mullins et al., 1992). Genetic resources that are available to the grapevine research community have increased enormously in parallel to a renewed interest in grapevine germplasm resources and analysis of genetic diversity in grapes. It is well recognized that genetic variation is invaluable for crop improvement and understanding gene function, and this fact applies to grapevine as well (This et al., 2006b; De Lorenzis et al., 2015). The results obtained after the morphological and biochemical characterization of various grapevine genotypes with respect to physical and biochemical traits of grape bunch and berry are discussed in this article.

Physical and Biochemical Berry parameters

Physical Berry parameters: In the present study, berry length ranged from 9.60 to 23.50 mm whereas berry width ranged from 8.90 mm to 17.40 mm for all the genotypes. Abiri et al. (2020) also reported that berry length ranged from 12.32 to 31.85 mm and berry width varied from 10.55 to 23.45 mm (Abiri et al., 2020). Khadivi-Khub et al. (2014) observed the range of 10.00–34.00 mm for berry length and 7.00–23.00 mm for berry width. Vafaee *et al*. (2017) reported the range of 9.80–30.30 mm for berry length. Grape breeding in the East and Iran has focused on the development of table grapes with desirable traits like large berry and bunch size (Bouquet, 2011). Since the differences between berry length and width were significant for all the genotypes in the present study, the values of the berry shape index were also found to be significant. In the present investigation, the values for berry weight varied between 0.91 g to 7.10 g. Similarly, Abiri et al. (2020) reported that the berry weight varied from 0.64 to 3.47 g. Furthermore, Khadivi-Khub et al. (2014) reported a range of 1.50–5.94 g for an Iranian grape collection, while Barbagallo et al. (2011) reported berry weight varying from 1.30 to 2.75 g. In the present experiment, the berry volume values were in accordance with the berry weight values. In the present investigation, five types of berry shapes were recorded including, round (13 genotypes), elliptic (2), narrow elliptic (4), obtus-ovate (2) and, ovate (1). Also, Abiri et al. (2020) reported the eight types of berry shapes including oblong (7 cultivars), narrow-elliptic (8), elliptic (13), round (16), oblate (1), ovate (5), obtuse-ovate (4), and obovate (1). Further, KhadiviKhub et al. (2014) observed three types of berry shapes namely, oblong, elliptic, and round. In the present study, most of the cultivars were found with well-developed seeds (15), seedless (2), and with rudimentary seeds (5). Seedlessness is a valued trait in commercially grown table grapes (Reisch et al., 2012). However, Abiri et al. (2020) observed that the Perlet cultivar was seedless, and 20 cultivars formed seeds as rudimentary, while seeds were welldeveloped in 34 cultivars. Vafaee et al. (2017) reported that most of the cultivars (23 out of 33 cultivars) showed well-developed seeds, while rudimentary seed formation was observed in eight cultivars and two cultivars were seedless. Seed number per berry ranged from zero to four, and most of the cultivars (33) had two seeds in a single berry. Boz et al. (2011) recorded one to four seeds per berry for Turkish grapes. Khadivi-Khub et al. (2014) reported the range of zero to four seeds per berry for an Iranian grape collection, while Vafaee et al. (2017) reported that seed number per berry ranged from zero to three. In the present investigation, a significant variation was found for the berry skin color among the different genotypes under the study such as deep red (2) red (3) blue-black (3) greenyellow (8) dark red-violet (5). Recently, Abiri et al. (2020) recorded those 10 types of berry skin color were observed and light green (14 cultivars) and yellowish-green (15) colors were predominant. Khadivi-Khub et al. (2014) and Vafaee et al. (2017) identified nine and four color categories for Iranian grapes, respectively. Berry skin color is an important indicator of fruit ripeness and the harvest date of some fruits. Furthermore, cultivars with different berry skin colors can be satisfying for various consumer preferences (Vafaee et al., 2017). In the present study, 19 cultivars were recorded with weak pulp color while 2 cultivars and 1 cultivar were recorded with medium pulp color and strong pulp color, respectively. In the present study, all the genotypes were classified as soft (3), medium-firm (14), and, firm (5) for berry firmness. Similarly, Basheer-Salimia (2015) categorized the genotypes for berry firmness as firm (13), medium-firm (5), and, soft (1).

Berry biochemical parameters: Grape being of non-climacteric nature, the berry maturity time is one of the most important factors influencing the future of quality grape production. The technological maturity of grapes is associated with the accumulation of a certain amount of sugars, titratable acidity, and, pH value. Therefore, it is suggested to harvest the grapes at the stage when the berry attains characteristics and optimum levels of TSS/TA ratio. In the present investigation, the values of TSS ranged from 14.07 ˚B to 21.70 ˚B. Abiri et al. (2020) reported that TSS ranged from 11.09 to 21.67%. Genotypes with high berry weight and high TSS are currently of interest to fruit breeders. Moreover, from a practical point of view, the significant positive correlations reported between TSS and total sugars, and the fact that those characteristics are associated,

suggest that high TSS can be used as an indirect measure to select genotypes for high total sugar (Barbagallo et al., 2011). The maturity index is the ratio between the TSS and TA, which represents a balance between sugar and acid, is very important to the general quality (Mota et al. 2006). Taste and flavour are the outcome of complex attribute of quality, in which there is blend of sugars, acids, and volatiles in a balanced ratio (Baldwin 2002). The flavour and taste metabolites are the outcome of sugar (TSS) and organic acid (total titratable acidity expressed as tartaric acid) in a certain ratio (Ferguson and Boyd 2002, Shiraishi et al. 2010). Significant variations were observed in the sugar-acid ratio, which ranged from 17.47 – 95.11. Similarly, Sahoo et al. (2018) reported that the sugar-acid ratio ranged from 16.99 to 35.28. In the present investigation, the pH of the berries ranged from 3.50 to 4.50 for all the genotypes whereas the titratable acidity percentage ranged from 0.23 % to 1.20 %. Similarly, Sahoo et al. (2018) recorded the pH of the different grape genotypes from 3.05 to 3.78 whereas the titratable acidity percentage ranged from 0.59 % to 1.05 %. In the present investigation, the values vitamin C ranged from 11 to 37.20 mg/100 g. Also, Sahoo et al. (2018) reported that the values of vitamin C ranged from 6.44 to 7.12 mg/100 g.

V. SUMMARY AND CONCLUSION

The present investigation entitled "physical and biochemical characterization of grape genotypes grown under Kandahar Province of Afghanistan for quality traits" was carried out during on 2020 at Kohkaran Research Farm which was established by Perennial Horticulture Development Center (PHDC), Ministry of Agriculture, Irrigation and Livestock (MAIL), based on Kandahar, Afghanistan. There were 22 grape varieties namely Kandahari Sorkh, Exotic, Sahibi Sra 488, Fantasy, Perlette, kishmeshi Sia, Tashkandi, Black Emerald, Aqa Ali 876, Manaqa 801, Lokh Shetor, Shirahmadi Heart, Husaini, Awi, Lal Sia, Typi, Loghi, Shaker, Lal Katadana, Mahmodi, Lal Maida Dana and Flame Seedless.

The salient features of the experimental results are being summarized as below:

- The maximum berry length (23.50 cm) was obtained in Lokh Shetor, followed by Husaini (23.50 cm) and Manaqa 801 (22.90 cm). While the minimum berry length (9.60 cm) was noted in Perlette. The maximum width of berry was recorded for Manaqa 801 (17.40 cm) followed by Loghi (17.40 cm), Sahibi Sra 488 (17.20 cm), Lokh Shetor (17.10 cm) and Typi (17.00 cm), and the minimum (8.90 cm) was noticed in Perlette.
- As regards, the different varieties of grapes had a significant effect on length to width ratio and the maximum length to width ratio (1.70) was recorded in Husaini. Whereas minimum length to width ratio (1.03) was noted in Flame Seedless.
- The maximum berry weight (7.10 g) and berry volume of five berries (34.00 ml) were noticed in Exotic and the minimum berry weight (0.91 g) was recorded in Lal Sia while the minimum berry volume (8.00 ml) for five berries was recorded in Kishmeshi Sia and Tashkandi.
- There were differences found in berry shapes for all the varieties. The varieties Kandahari Sorkh, Exotic, Perlette, kishmeshi Sia, Black Emerald, Shirahmadi Heart, Awi, Lal Sia, Loghi, Lal Katadana, Mahmodi, Lal Maida Dana, and Flame Seedless had round shape, while the Sahibi Sra 488 and Shaker produced Elliptic shape, Fantasy, Manaqa 801, Lokh Shetor and Husaini had Narrow elliptic shape, Tashkandi had ovate shape, Aqa Ali 876 and Typi showed obtus ovate shape.
- The data revealed that among all the varieties, Kandahari Sorkh, Exotic, Sahibi Sra 488, Aqa Ali 876, Manaqa 801, Lokh Shetor, Shirahmadi Heart, Husaini, Awi, Typi, Loghi, Shaker, Lal Katadana, Mahmodi, and Lal Maida Dana produced well developed seeds, while in Fantasy Seedless, Perlette, kishmeshi Sia, Tashkandi, Black Emerald and Lal Sia seeds were rudimentary, and the seeds were absent in Flame Seedless.
- The data observed from the research show that among all the varieties, Kandahari Sorkh had Dark red color, Exotic, Fantasy and Loghi have blue-black color, Sahibi Sra 488, Aqa Ali 876 and Lokh Shetor have red color, Perlette, Shirahmadi Heart, Husaini, Awi, Typi, Shaker, Lal Katadana, Mahmodi, and Lal Maida Dana have a green-yellow color, kishmeshi Sia, Tashkandi, Black Emerald, Manaqa 801 and Lal Sia have dark red violet color and Flame Seedless had deep red color.
- The data show that Kandahari Sorkh, Fantasy, Perlette, Tashkandi, Aqa Ali 876, Shirahmadi Heart, Husaini, Awi, Typi, Shaker, Lal Katadana, Mahmodi, Lal Maida Dana, Flame Seedless have Absence or weak pulp color, Exotic has strong pulp color, Sahibi Sra 488, kishmeshi Sia, Manaqa 801, Lokh Shetor and Lal Sia have weak pulp color, Black Emerald and Loghi have medium pulp color.

Among all the varieties, Awi, Lal Sia, and Loghi have soft berry, whereas, Kandahari Sorkh, Fantasy, Perlette, kishmeshi Sia, Tashkandi, Black Emerald, Aqa Ali 876, Manaqa 801, Shirahmadi Heart, Husaini, Shaker, Lal Katadana, Mahmodi, and Lal Maida Dana have medium berry and Exotic, Sahibi Sra 488, Lokh Shetor, Typi, and Flame Seedless have firm berry.

VI. CONCLUSION

Based on results obtained from the present investigation, it can be concluded that different result achieved from different varieties, Longest berry length was seen in Lokh Shetor but shortest in Perlette, berry width was maximum in Manaqa 801 but minimum in Perlette, Length to width ratio was highest in Husaini but lowest in Flame Seedless, berry

weight and berry volume were highest in Exotic but the lowest were in Lal Sai and Kishmeshi Sai. Awi, Lal Sai and Loghi had soft berries but Exotic, Sahibi Sra 488, Lokh Shetor, Typi and Flame Seedless had firm berries. Juice PH was the maximum in Shirahmadi Heart but the minimum in Black Emerald, TSS was highest in Lal Maida Dana but lowest in Exotic, Acidity was highest in Kishmeshi Sia but lowest in Fantasy, TSS/Acidy ration was maximum in Fantasy but minimum in Kishmeshi Sai, Vitamin C was highest in Typi but lowest in Fantasy. It can be concluded that different varieties showed variability in different bunch and berry parameters and based on the utility and purpose these varieties may be chosen for their commercial cultivation.

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