PHYSICAL AND BIOCHEMICAL CHANGES IN COMMONLY GROWN GRAPES (*Vitis vinifera*) IN PAKISTAN AT DIFFERENT MATURITY LEVELS

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ABSTRACT: Commonly grown varieties of grapes in Pakistan are Askari, Haita, Kala, White Kishmish, Sahibi, Shandao Khani and Tor. Physical and biochemical characteristics of these varieties of grapes were studied at different maturity levels. Moisture and sugar contents of various varieties of grapes increased with maturity, whereas fiber, ash and protein contents decreased as the fruits mature. Maximum sugar and moisture contents were observed in mature Shandao Khani. Almost similar concentrations of protein were estimated in all varieties of grapes at different maturity levels. Ash and fiber contents were maximum in Tor at different maturity levels. With increase in sugar contents, fiber and ash contents decreased at different maturity levels, developing an inverse relationship between sugar contents and ash & fiber contents. Similarly, a direct relationship was observed between moisture and sugar contents in different varieties of grapes at different maturity levels. Biochemical composition of different varieties of grapes changed rapidly from immature to mature grapes, whereas there was only a slight variation in chemical composition from mature to over-mature grapes.

Keywords: *Grapes; Maturity Levels; Physical and Biochemical Characteristics.*

INTRODUCTION

Grape is one of the most remunerative summer fruit crops, native to warm, temperate zone between 34°N and 49°S latitude. Mountainous and sub-mountainous areas up to 2000m altitude or more are suitable for its cultivation. In Pakistan, grapes are grown on an area of 13,000 hactors with annual production of 49 thousand tones (Qurashi and Ahmad, 2004).

Grapes belong to genus Vitis which comprises about sixty species. However, the principal species from which the cultivated grape has been derived is *Vitis vinifera.* There are three broad divisions of grapes: dessert grapes, wine grapes and raisin grapes. Grapes, a popular home grown fruit,. are consumed as fresh table grapes, juices and wine, as raisins, jam and jelly and as frozen products. In Pakistan only European grapes are cultivated for eating. and 70% of grapes are grown in Balochistan, while there is some acreage in NWFP (PARC, 2005). Grapevines can grow on a wide range of soil types, preferably a slightly acidic soil with a pH of 6.0 to 6.5 and require approximately 1 inch of water per week through the first growing season (Jauron *et al.*, 1997).

The degree of fruit ripeness vary depending on the intended use of the grapes. Therefore, an awareness of the ripening process and its impact on fruit quality is important for consumers as well as home and commercial grape growers. Grapes undergo many changes during the ripening process. As this process proceeds, it may be difficult to select the time at which the grape is ready for harvest (Algood and Lockwood, 2006). Color, size, sweetness, and flavor of the berry are the most useful indicators of grape matusity Depending on the variety, berry color changes from green to blue, red, or white as the grapes approach maturity. Color alone, however, should not be the sole basis for harvesting grapes (Jauron *et al.*, 1997).

Physical maturity of grapes is defined as the stage when the fruit reaches its largest diameter and maximum sugar content. Technological maturity defines the picking time in relation to the ultimate utilization of the grape. The rate, at which grapes mature, as well as their time of ripening, is governed by several factors. Changes in grape ripening will occur only as long as the grapes remain on the vine (Algood and Lockwood, 2006).

Water is by far the most abundant constituent in grapes (75-85%), acting as a solvent of volatile and fixed chemical compounds (Blouin and Cruège, 2003). Grape berry development is closely related to water availability in the soil. Berry volume per

vine, which sets the limit of crop production, depends on berry number and water volume per berry (Delrot *et al.*, 2001). Fruit volumetric growth is primarily the result of water accumulation. Water deficit generally leads to smaller berries since it inhibits both cell division and, especially, cell expansion. Grape berries are very rich in potassium, an essential macronutrient for grapevine and grape berry growth and development. Sugar content is an indicator often used to assess ripeness and to mark the harvest (Conde *et al.*, 2007). Proteins are present in widely varying quantities in grapes and are also of economical importance, and hey affect the clarity (translucency) of the wine (Ferreira *et al.*, 2002).

Grape berries function as a sophisticated biochemical factory, and import and accumulate water, minerals, sugar, amino acids, organic acids, and synthesize flavour and aroma compounds. The present study is aimed on the major physical and biochemical changes in commonly grown grapes of Pakistan during different stages of their maturity.

MATERIALS AND METHODS

Seven varieties of grapes (*Askari, Haita, Kala, White Kishmish, Sahibi, Shandau-Khani and Tor*) were selected for the study. The grapes were procured from whole sale market and were divided into three lots on the basis of their maturity: i) Immature, ii) Mature and iii) Over-mature. For this purpose, a panel of four experts was constituted to segregate the grapes into three categories on the basis of physical characteristics (color, shape and size of grape berries). The grapes were washed gently by soaking in fresh water to remove any adhering soil or foreign material.

The grapes were characterized for various physical and biochemical parameters. Physical parameters (shape, size, skin, color, seeds and taste) while biochemical analyses of grapes for moisture, fiber, protein, ash and sugars were carried out. Triplicate analyses were made for all parameters. Moisture contents were estimated by AOAC official method (2005).

Protein contents were estimated through kjeldahl apparatus. Sugar, Crude fiber and ask contents estimated through the produce described by AOAC (2005).

Clarified and neutral solution of blended grapes was prepared and titrated against Fehling's solution using methylene blue indicator for estimation of sugar.

RESULTS AND DISCUSSION

Physical characteristics of different varieties of grapes are presented in table 1. Askari, White Kishmish and Shandao Khani were seedless varieties with sweet taste and, therefore, have good quality for local and international markets. The taste of Kala and Tor was sourish sweet, for which their use as table grapes is rare. Amongst different varieties, oval shaped Sahibi was observed to be the largest in size (2.2 x 1.9 cm) while oblong shaped Askari was of small size (1.2 x 1.0 cm). Chemical composition of different varieties of grapes at three different maturity levels, were studied. Results are presented in table 2. Changes in moisture, fiber, protein, ash and sugar contents during different stages of maturity were analyzed. Maximum moisture contents (69.3 – 83.9%) were observed in Shandao Khani while Haita showed minimum moisture contents (63.5 – 81.5%) at different maturity levels. Fig. 1 shows moisture contents in different verities of grapes at three maturity levels.

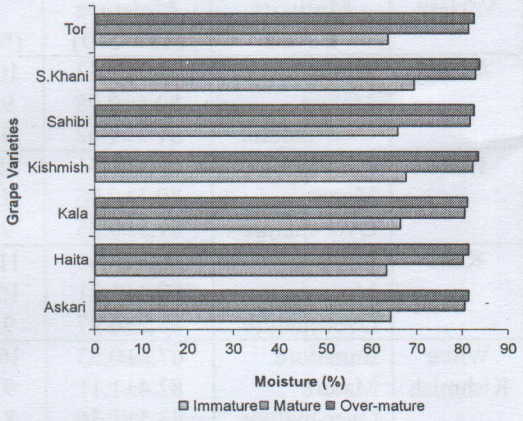

Fig 1: Moisture contents in different varieties of grapes at different maturity levels.

Variations (either increase or decrease)

in various biochemical constituents of different varieties of grapes at different maturity levels are presented in table 3. It was observed that moisture contents increased with ripening of fruit in all varieties of grapes.

Table-1. Physical Characteristics of different Varieties of Grapes in Pakistan.

Variety	Shape	Size (cm)	Skin	Color	Seeds	Taste
Askari	Oblong	1.2x1.0	Thin, Tender	Creamy Yellow	Seedless	Sweet
Haita	Oval	1.99x1.9	Thin, Tough	Pale Green	1-2 large light brown Seeds	Sweet
Kala	Oval	1.8x1.5	Thick, Tough	Black	1-2 dirty white Seeds	Sourish Sweet
White Kishmish	Oblong	1.5x1.2	Thin, Hard	Pale Yellow	Seedless	Very Sweet
Sahibi	Oval	2.2x1.9	Thin, Tender	Yellowish with Reducible Pigments	1-3 medium brown with blunt reddish tip Seeds	Sweet
Shandao Khani	Oval	1.9x1.1	Thick, Tender	Pale Yellow	Seedless	Very Sweet
Tor	Globose	1.98x1.9	Thick, Tough	Dark Purple	1-4 fairly large brown Seeds	Sourish Sweet

Table-2. Biochemical composition* of grapes at different maturity levels.

Variety	Maturity Levels	Moisture (% ± S.D)	Fiber (% ± S.D)	Protein (% ± S.D)	Ash (% ± S.D)	Sugars (% ± S.D)
Askari	Immature	64.3±1.43	10.8±1.21	3.6±0.43	1.6±0.91	58.8±1.21
	Mature	80.6±0.98	9.6±1.39	3.3±0.21	1.4±0.83	77.6±1.79
	Over-mature	81.3±1.02	9.3±2.01	3.0±0.56	1.3±0.66	83.8±0.99
Haita	Immature	63.5±0.51	11.4±1.43	3.7±0.11	1.7±0.68	60.4±0.78
	Mature	80.1±0.96	10.3±1.55	3.2±0.72	1.5±0.98	80.8±0.47
	Over-mature	81.5±0.85	9.9±1.26	3.0±0.65	1.4±0.32	82.7±1.03
Kala	Immature	66.3±0.63	11.5±1.43	3.8±1.07	1.8±0.47	48.6±1.67
	Mature	80.4±1.21	10.2±2.07	3.4±0.92	1.4±0.43	65.8±1.43
	Over-mature	81.2±0.97	9.8±1.87	3.2±0.85	1.3±0.59	72.7±1.21
White Kishmish	Immature	67.6±0.53	10.5±1.27	3.5±0.49	1.5±0.72	67.8±1.01
	Mature	82.4±1.11	9.2±2.01	3.1±0.32	1.3±0.81	83.0±1.66
	Over-mature	83.5±1.36	8.7±1.99	2.8±0.36	1.2±0.11	85.9±1.27
Sahibi	Immature	65.9±2.01	10.8±1.86	3.9±0.78	1.7±0.37	55.4±1.32
	Mature	81.8±0.76	9.6±0.91	3.6±0.62	1.5±0.72	71.5±1.14
	Over-mature	82.7±0.91	9.4±0.99	3.4±0.17	1.4±0.86	74.8±1.65
Shandao Khani	Immature	69.3±1.99	10.9±2.01	3.7±1.21	1.6±0.57	68.5±0.97
	Mature	82.8±1.03	9.6±1.46	3.2±0.93	1.4±0.21	84.6±0.24
	Over-mature	83.9±0.79	9.3±1.23	3.1±0.65	1.3±0.63	91.9±1.36
Tor	Immature	63.8±0.55	11.6±1.77	3.8±0.32	1.9±0.11	55.5±1.09
	Mature	81.4±0.21	10.8±1.21	3.4±0.59	1.6±0.48	64.8±1.11
	Over-mature	82.7±1.06	9.7±1.76	3.2±0.67	1.5±0.39	68.5±1.57

* Average of triplicate measurements
S.D Standard Deviation

Table-3. Variations in biochemical constituents of grapes at different maturity levels.

Variety	Maturity Levels	Moisture (% Increase)	Fiber (% Decrease)	Protein (% Decrease)	Ash (% Decrease)	Sugars (% Increase)
Askari	Immature to Mature	25.3	11.1	8.33	12.5	31.9
	Mature to Over-mature	0.87	3.12	9.09	7.14	7.99
Haita	Immature to Mature	26.1	9.65	13.5	13.5	33.8
	Mature to Over-mature	1.75	3.88	6.25	6.66	2.35
Kala	Immature to Mature	21.3	11.3	10.5	10.5	35.4
	Mature to Over-mature	0.99	3.92	5.88	7.14	10.5
White Kishmish	Immature to Mature	21.9	12.4	11.4	13.3	22.4
	Mature to Over-mature	1.33	5.43	9.68	7.69	3.49
Sahibi	Immature to Mature	24.1	11.1	7.69	11.7	29.1
	Mature to Over-mature	1.10	2.08	5.55	6.67	4.61
Shandao Khani	Immature to Mature	19.5	11.9	13.5	12.5	23.5
	Mature to Over-mature	1.33	3.12	3.12	7.14	8.63
Tor	Immature to Mature	27.6	6.89	10.5	15.8	16.8
	Mature to Over-mature	1.60	10.2	5.88	6.25	5.71

A maximum of 27.6% increase in moisture was observed in Tor from immature to over-mature level. Moisture contents increased rapidly from immature to mature grapes, while from mature to over-mature grapes there was only a slight increase in moisture contents. It was also observed that size of grape berry is dependent on moisture contents. These results are in agreement with those reported by Delrot *et al.*, (2001) that with increase in moisture contents grape berry volume also increases.

Fiber, protein and ash contents of grapes decreased with maturity as shown in figures 2, 3 and 4 respectively. Immature grapes showed maximum contents of fiber, protein and ash.

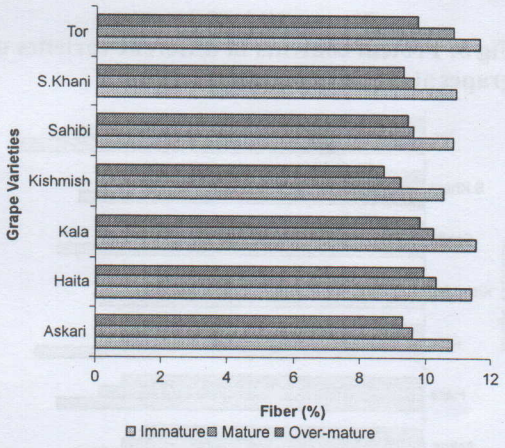

Fig 2: Fiber contents in different varieties of grapes at different maturity levels.

Maximum fiber contents (9.7 – 11.6%) were observed in Tor, whereas minimum fiber contents (8.7 – 10.5%) were observed in White Kishmish, at immature and mature levels. A rapid decrease in fiber contents was observed in immature to mature fruits of all varieties of grapes except Tor where

fiber contents increased comparatively more rapidly from mature to over-mature level.

Protein contents ranged from 3.0 – 3.9% in different varieties of grapes at different maturity levels. Maximum protein contents (3.4 – 3.9%) were observed in Sahibi at different levels of maturity. Protein contents decreased with maturity in all varieties of grapes with a maximum decrease of 13.5% in Haita and White Kishmish from immature to mature stage.

Sugar contents varied from 48.6 – 91.9% in different varieties of grapes at different maturity levels. Increase in sugar contents was observed from immature to over-mature grapes of different varieties (fig. 5).

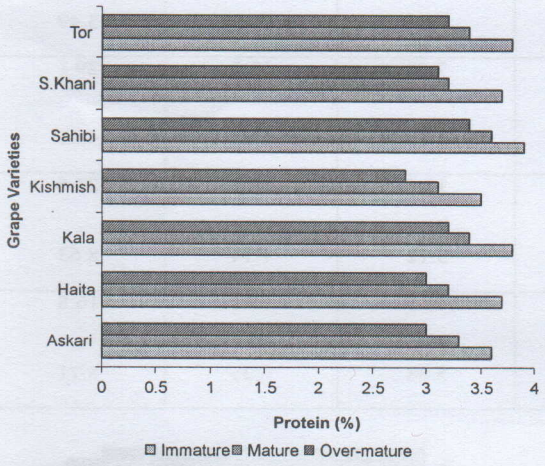

Fig 3: Protein contents in different varieties of grapes at different maturity levels.

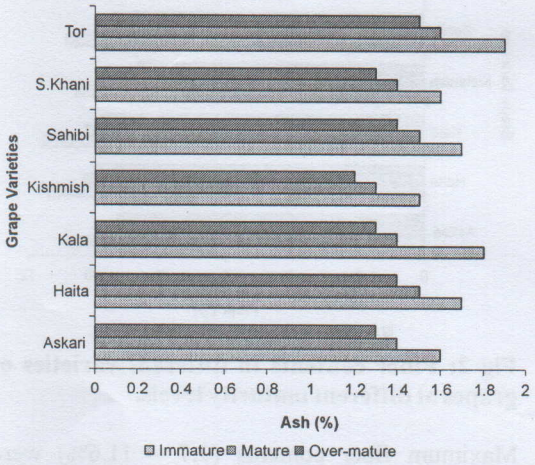

Fig 4: Ash contents in different varieties of grapes at different maturity levels.

Conde et al. (2007) reported that at maturity sugar contents are maximum and can be indicator of ripeness. Maximum sugar contents (68.5 – 91.9%) were observed in Shandao Khani grapes at different stages of maturity.

A sharp increase in sugar contents (35.4%) was observed in Kala from immature to mature grapes. Sugar contents increased more from immature to mature grapes as compared from mature to over-mature grapes in all varieties.

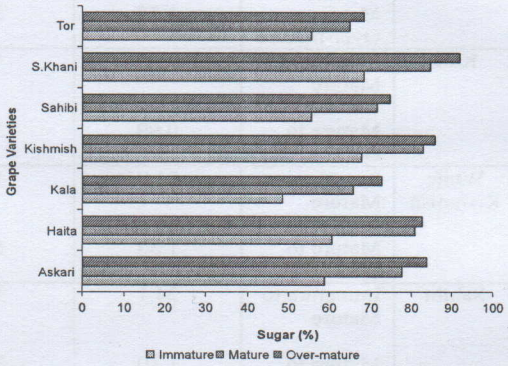

Fig 5: Sugar contents in different varieties of grapes at different maturity levels.

Moisture and sugar contents of various varieties of grapes increased with maturity, whereas fiber, ash and protein contents decreased as the fruits mature. Maximum sugar and moisture contents were observed in mature Shandao Khani. Almost similar concentrations of protein were estimated in all varieties of grapes at different maturity levels. Ash and fiber contents were maximum in Tor at different maturity levels. With increase in sugar contents, fiber and ash contents decreased at different maturity levels, developing an inverse relationship between sugar contents and ash & fiber contents. Similarly, a direct relationship was observed between moisture and sugar contents in different varieties of grapes at different maturity levels. Biochemical composition of different varieties of grapes changed rapidly from immature to mature grapes, whereas there was only a slight variation in chemical composition from mature to over-mature grapes. Sugar and moisture contents an the indicators of fruit ripening in grapes, as also reported by Conde *et al.* (2007).

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