Genotypic Variation in Physico-Chemical Properties of Avocado at Dailekh

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ABSTRACT

This study was conducted to analyze the physical and chemical properties of the fruits in 16 avocado genotypes in 2020. Fruits were harvested at physiological maturity stage from seed propagated plants and analyzed their physical (fruit weight, fruit length, fruit diameter, pulp weight, pulp/fruit ratio, and seed/fruit ratio) and chemical properties (moisture content, reducing sugar, total soluble solids, crude protein, total ash, phosphorous, iron, calcium, crude fat and crude fiber). The analysis of one-way variance of the data revealed highly significant variation in physico-chemical properties among avocado genotypes. Genotypes HRSDAV05, HRSDAV07, HRSDAV06 and HRDAV03 displayed the lowest seed/fruit ratio of 10.0, 13.5, 14.6 and 16.8%, respectively. Total soluble solid (TSS) content was the highest in HRSDAV08 (6.7 °Brix), HRSDAV03 (6.0 °Brix), HRSDAV07 (6.0 °Brix) and HRSDAV012 (6.0 °Brix). Crude protein was the highest in HRSDAV07 (19.2%), HRSDAV09 (17.8%) and HRSDAV014 (17.4%). HRSDAV03 and HRSDAV012 had the highest total ash content of 6.4% and 5.1%, respectively. Phosphorus content was the highest in HRSDAV03 (235.2 mg/100 g), but iron content was the highest in HRSDAV07 (2.5 mg/100 g). Crude fat and crude fiber were the highest in HRSDAV013 (63.0%) and HRSDAV03 (48.4%), respectively. The analysis of physico-chemical characters of avocado fruits identified HRSDAV03, HRSDAV05, HRSDAV06, HRSDAV07, HRSDAV08, HRSDAV09 and HRSDAV013 as potential parental genotypes for developing new cultivars.

Keywords: Avocado, Crude protein, Crude fat, Pulp weight, TSS

1. INTRODUCTION

Avocado (*Persea americana* Mill) is an evergreen fruit plant belonging to the family Lauraceae (Talabi *et al*. 2016). It is a tropical tree, originated in Mexico, Central America and South America, but it is now cultivated worldwide (Adodo, 1995). Avocado fruit has a multipurpose value, such as food, medicine, source of high quality oil and many industrial uses (Human 1987; Bergh 1992). Avocado fruit is a large fleshy berry with a single seed and it is the most nutritious of all salad fruits. The edible flesh has low sugar content, high oil content, and rich in vitamins A, B1, B2, D, and E. The avocado pulp is also used as the treatment of dry skin, protective agents against ultraviolet radiation, and anti-aging agents (Korac & Khambholja 2011). Avocado reduces the risk of cardiovascular disease (Valery *et al*. 2011).

In Nepal, five avocado varieties (Hass, Fuerte, Ettinger, Reed and Topatopa) had been introduced at National Fruit Development Center, Kirtipur, Kathmandu, Horticulture Development Farm, Trishuli and Horticulture Development Farm, Sarlahi in 1978 (Atreya 2020). After the establishment of Pakhribas Agriculture Research Center (PARC), Dhankuta in 1972, avocado varieties had also been introduced by researchers and tourists of United Kingdom. Since then, farmers have been growing the avocado trees in their backyard areas. It is known as *Ghiu phal* in Nepali (Atreya 2020) and considered as an emerging new fruit (Poudel *et al*. 2018). Nowadays, avocado fruit is very much appreciated in the market due to its nutritional value.

Avocadoes are categorized into Guatemalan, Mexican and West Indian botanical groups which are also referred to as horticultural races (Morton 1987; Bergh 1992). West Indian race is well adapted in tropical climate while the Guatemalan and the Mexican accessions are well adapted to cold climate (Bergh 1992; Juma *et al*. 2020). In Nepal, avocado is grown mainly for fruit purpose in government's farms and farmers' home-yards. Since avocado is a cross pollinated fruit crop, seed-propagated avocado plants show high genetic diversity (Juma *et al*. 2020). Avocado fruits show wide variation in size, shape, weight and chemical composition which depend on the variety, the climate condition, and the agricultural practices (Pino *et al*. 2004). Research studies in fruit and seed's physical characters were undertaken at eastern Nepal (Poudel *et al*. 2018). Nevertheless, physico-chemical properties of the fruits in seed-propagated avocado genotypes have not been studied so far. Thus, the present study aimed at determining and comparing the physico-chemical composition of fruits of the different avocado genotypes maintained at Dailekh.

2. MATERIALS AND METHODS

2.1 Plant Materials

Seed propagated avocado seedlings were collected from Agriculture Research Station, Pakhribas, Dhankuta (1,740 masl), Horticulture Development Farm, Trishuli, Nuwakot (1,022 masl) and Horticulture Research Station, Malepatan, Pokhara (845 masl) and were planted at HRS, Dailekh (28˚50'49.8" N and 81˚43'19.4" E with an altitude of 1,255 masl) in 2012. This station represents the mid-hills of Nepal and experiences sub-tropical climate. The annual rainfall ranges between 140 mm and 160 mm and mosly occurs in June-July. The annual temperature ranged from 6.1 to 28.7 °C (HRS, 2020). But the average temperature in fruit bearing period (March-October) at Dailekh ranged from 8.6 to 24.1 °C (HRS 2020). Avocado trees were grown at the similar ecological condition with similar agronomic and cultural management practices. Trees (eight years old) started to flower and fruit in 2020 and trees were nomenclatured as HRSDAV, where 'HRSD' stands Horticulture Research Station, Dailekh and 'AV' stands for 'Avocado' and 01, 02 and successive numbers were given to each tree for their identification. Total 16 trees were named which produced diverse fruit shapes and colors, and fruit morphology of 16 avocado genotypes is given in Fig. 1.

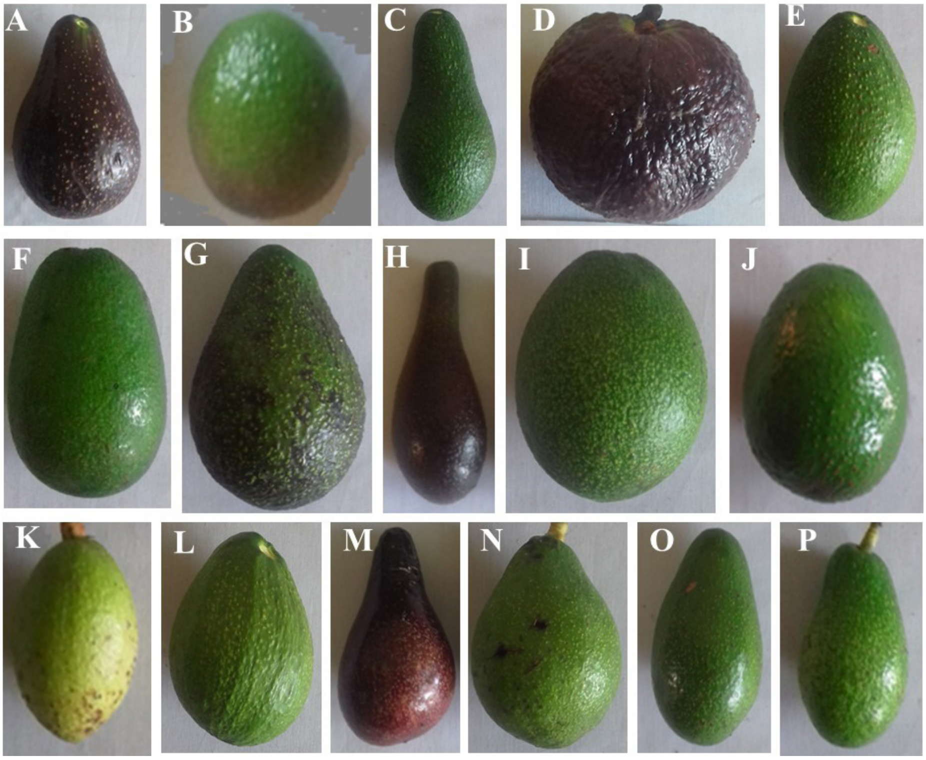

Fig. 1. Fruit morphology of avocado genotypes studied for physico-chemical properties at HRS, Dailekh. A = HRSDAV01, B = HRSDAV02, C = HRSDAV03, D = HRSDAV04, E = HRSDAV05, F = HRSDAV06, G = HRSDAV07, H = HRSDAV08, I = HRSDAV09, J = HRSDAV010, K = HRSDAV011, L = HRSDAV012, M = HRSDAV013, N = HRSDAV014, O = HRSDAV015, and P = HRSDAV016

2.2 Physical Properties of The Fruits

A total of nine fruits were harvested on October 10, 2020 at their physiological maturity stage from each genotype and kept at laboratory condition (20.0±3.5 °C) until ripe. This experiment was laid out completely in randomized design (CRD) where three replications and three fruits were allotted at each replication. Fruit weight (g) and seed weight (g) were measured on three ripened fruits using electronic digital weight scale (H-HondaTM) and averaged it. Fruit length (cm) was measured as the longest part of the fruit using a stainless 60 cm ruler and fruit diameter (cm) was measured using Vernier digital caliper as the mid-section of each fruit. Pulp weight (g) was measured using electronic digital weight scale (H-HondaTM). Pulp/fruit ratio was expressed in percentage as (pulp weight/fruit weight) *100. Seed/fruit ratio was calculated in percentage as (seed weight/fruit weight) *100.

2.3 Chemical Properties of The Fruits

Three fruits from each genotype were randomly selected based on their firmness, absence of mechanical damage and visible decay and harvested at the onset of ripening. The fruits were transported to the laboratory of National Food Research Centre (NFRC), Khumaltar in cardboard boxes and placed in laboratory condition (20.0±3.5 °C) until fully ripen. Fruits free from any apparent skin damage were selected for chemical analysis. The fruits were thoroughly washed and pulp was manually removed. The peels and seeds were separated using a domestic blender. Moisture content was determined by drying the sample in a hot air oven at 105±1 °C to a constant weight as described by Ranganna (2002). Reducing sugar was estimated according to method described in AOAC (2005). Ten-gram fruit sample was weighed and transferred to 250 mL volumetric flask. Then, 10 mL neutral lead acetate solution

(20%) was added, diluted to volume with distilled water and filtered. Then, 25 mL of the filtrate was transferred to 500 mL volumetric flash with 100 mL distilled water. Few drops of potassium oxalate solution (10%) were added until there were no further precipitations made up to volume, mixed well and filtered. The filtrate was then used for further titration. Then, 5 mL of each Fehling A and B was taken with 10 mL distill water in a 250 mL conical flask, heated to boiling and titrated with the sample solution to determine reducing sugar content. Reducing sugar (%) = (mg. of invert sugar x vol. made up x 100)/ (titre value x wt. of sample x 1000).

Three fruits from each genotype were ground, and then homogenate were filtered (Filter paper, 90 mm, Lot No. 20, Hyundai). TSS was determined using hand-held digital refractometer (Atago, Japan) and the values were expressed as °Brix. Crude protein, crude fat, crude fiber and total ash content were determined according to methods of AOAC (2005). Crude protein was calculated from the nitrogen content by Micro-Kjeldahl method multiplying total nitrogen by factor 6.25. Crude fat was determined by continuous extraction in a Soxhlet apparatus (J.P. Selecta-Spain) for three hours using petroleum ether as solvent. The fat was recovered by evaporating away the solvent. Ash content was determined by incinerating the sample at 550 °C in a muffle furnace. After cooling to room temperature, the ash was weighed and calculated. Minerals (phosphorous, iron and calcium) content was analyzed from the ash suspension according to the method described by Ranganna (2002). All the chemical analyses were carried out in triplicate.

2.4 Statistical Analysis

Data were analyzed by one-way analysis of variance (ANOVA) using GenStat Release 10.3 DE Software (VSN International Ltd., UK). Significant differences between the mean values of different characteristics were determined by Duncan's Multiple Range Test (DMRT) at the probability of 5% ($P \leq 0.05$). Graphs were prepared using Sigma Plot (v.10.0.1.2, SPSS Inc, USA).

3. RESULTS

3.1 Physical Properties of The Fruits

Genotypes exhibited highly significant ($P \leq 0.05$) differences in fruit weight, fruit length, fruit diameter, pulp weight, seed weight, pulp/fruit ratio and seed/fruit ratio (Table 1). The fruits of HRSDAV06 genotype were significantly bigger in size than the fruits of other genotypes. The highest fruit weight (348.4 g) was measured in HRSDAV06 which was statistically similar to HRSDAV01 (310.0 g) and HRSDAV03 (302.1 g) and the lowest fruit weight (44.8 g) was recorded in HRSDAV011.The longest fruit (16.2 cm) was measured in HRSDAV08 which showed statistically similar to HRSDAV03, but the shortest fruit length (6.4 cm) was in HRSDAV011. The highest fruit diameter (7.5 cm) was measured in HRSDAV06, but it was statistically similar to HRSDAV05 (7.4 cm), HRSDAV09 (7.3 cm), HRSDAV01 (7.2 cm), HRSDAV012 (7.1 cm), HRSDAV015 (6.7 cm), HRSDAV07 (6.7 cm) and HRSDAV010 (6.6 cm). HRSDAV03 showed the highest pulp weight (243.8 g) which was statistically similar to HRSDAV01 (223.9 g) and HRSDAV06 (218.0 g), but the lowest pulp weight (30.7 g) was recorded in HRSDAV011. Similarly, the highest seed weight (59.6 g) was measured in HRSDAV014, but it exhibited non-significant difference from HRSDAV01 (53.6 g), HRSDAV015 (51.1 g) and HRSDAV06 (50.3 g) but the lowest seed weight (10.9 g) was recorded in HRSDAV011. Pulp/fruit ratio was highest in HRSDAV05 (87.5%), but it was statistically similar to HRSDAV03 (82.0%), HRSDAV09 (80.3%), HRSDAV07 (75.4%), HRSDAV015 (74.9%), and HRSDAV01 (73.5%) but the lowest pulp/fruit ratio (49.5%) was recorded in HRSDAV04. HRSDAV014 displayed the highest seed/fruit ratio (35.0%) and the lowest seed/fruit ratio (10.0%) was in HRSDAV05.

Table 1. Fruit physical properties of avocado genotypes at HRS, Dailekh, 2020

Genotypes	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Pulp weight (g)	Seed weight (g)	Pulp/fruit ratio (%)	Seed/fruit ratio (%)
HRSDAV01	310.0 ab	14.2 bc	7.2 abc	223.9 ab	53.6 ab	73.5 a-d	17.7 efg
HRSDAV02	162.9 ghi	7.2 ij	6.0 ef	103.4 fg	31.0 def	63.4 c-f	19.0 d-g
HRSDAV03	302.1 abc	14.9 ab	6.4 c-f	243.8 a	49.3 bc	82.0 ab	16.8 efg
HRSDAV04	142.1 i	7.0 ij	6.3 def	69.5 h	32.3 de	49.5 f	22.8 cde
HRSDAV05	226.4 def	11.2 fg	7.4 ab	195.4 cd	21.9 f	87.5 a	10.0 h
HRSDAV06	348.4 a	13.2 cd	7.5 a	218.0 abc	50.3 ab	63.2 c-f	14.6 fgh
HRSDAV07	273.5 bcd	12.7 de	6.7 a-e	205.4 bcd	36.8 de	75.4 a-d	13.5 gh
HRSDAV08	187.2 f-i	16.2 a	5.7 f	126.4 ef	33.9 de	67.9 b-e	18.2 d-g
HRSDAV09	160.2 hi	8.7 h	7.3 abc	127.8 ef	30.6 de	80.3 abc	19.1 d-g
HRSDAV010	198.0 fgh	9.2 h	6.6 a-e	105.9 fg	34.2 de	53.8 ef	17.2 efg
HRSDAV011	44.8 j	6.4 j	3.6 g	30.7 i	10.9 g	67.3 b-e	23.9 g
HRSDAV012	217.1 efg	9.5 h	7.1 a-d	137.3 e	40.0 cd	64.7 c-f	18.7 d-g
HRSDAV013	158.0 hi	11.2 efg	6.0 ef	92.3 gh	47.9 bc	58.4 def	30.4 ab
HRSDAV014	170.6 ghi	8.4 hi	6.5 b-f	103.8 fg	59.6 a	60.8 def	35.0 a
HRSDAV015	254.6 cde	11.6 ef	6.7 a-e	190.2 d	51.1 ab	74.9 a-d	20.0 def
HRSDAV016	165.1 ghi	9.8 gh	5.7 f	115.6 efg	27.8 ef	69.8 b-e	16.8 efg
Mean	207.6	10.7	6.42	143.1	38.2	68.29	19.6
F-Test	**	**	**	**	**	**	**
LSD (0.05)	48.45	1.36	0.78	24.99	8.86	14.84	5.37
CV (%)	13.9	7.64	7.33	10.47	13.68	13.03	16.07

** Significant at 0.01 level. The same letters in a column are not significantly different at P≤ 0.05; DMRT.

3.2 Chemical Properties of The Fruits

Results for fruits chemical properties of avocado genotypes are shown in Table 2. The analyses showed the highly significant (P≤0.01) differences in moisture content, reducing sugar, total soluble solids, crude protein, total ash, phosphorous, iron and calcium. The highest moisture content (84.4%) in pulp was observed in HRSDAV012 followed by HRSDAV05 (81.7%), HRSDAV01 (81.4%) and HRSDAV06 (80.1%), but pulp of HRSDAV013 had the lowest moisture content (72.9%). HRSDAV05 contained the highest reducing sugar (1.4 g/100 g) but the lowest reducing sugar (0.1 g) was found in HRSDAV016. Total soluble solid ranged from 3.0 to 6.7 °Brix with an average of 4.66 °Brix. The highest TSS (6.7 °Brix) was recorded in HRSDAV08, but it was not significantly different from HRSDAV03 (6.0 °Brix), HRSDAV07 (6.0 °Brix), and HRSDAV012 (6.0 °Brix) and the lowest (3.0 °Brix) was recorded in HRSDAV011. Highest crude protein (19.2%) was found in HRSDAV07, followed by HRSDAV09 (17.8%) and HRSDV014 (17.4%). Total ash content was highest (6.4%) in HRSDAV03, followed by HRSDAV012 (5.1%) and HRSDAV09 (4.9 g), but the lowest ash content (2.9%) was recorded in HRSDAV05 and HRSDAV06 each. Phosphorous content was highest (235.9 mg/100 g) in HRSDAV01 and HRSDAV03 (235.2 mg/100 g), but the lowest (147.8 mg/100 g) was in HRSDAV013. HRSDAV08 contained the highest iron (2.5 mg/100 g) and the lowest (0.4 mg/100 g) was in HRSDAV011. Likewise, HRSDAV08 had the highest calcium (1040.5 mg/100 g) and the lowest (467.4 mg/100 g) was in HRSDAV011.

Table 2. Fruits chemical properties of avocado genotypes at HRS, Dailekh, 2020

Genotypes	Moisture content (%)	Reducing sugar (g/100 g)	TSS (°Brix)	Crude protein (%)	Total ash (%)	Phosphorous content (mg/100 g)	Iron content (mg/100 g)	Calcium content (mg/100 g)
HRSDAV01	81.4 bc	0.2 ef	4.0 e	10.2 gh	4.5 cde	235.9 a	0.9 fgh	806.5 k
HRSDAV02	79.7 cde	0.4 de	4.3 de	10.7 fgh	4.7 cd	221.2 b	0.8 gh	765.7 m
HRSDAV03	79.6 cde	0.7 c	6.0 ab	14.7 d	6.4 a	235.2 a	1.1 f	997.9 d
HRSDAV04	30.8 bc	0.9 bc	5.3 bc	7.8 i	3.7 g	176.2 g	1.3 de	1004.6 c
HRSDAV05	81.7 b	1.4 a	4.0 e	11.9 ef	2.9 h	171.5 gh	1.2 ef	888.1 i
HRSDAV06	80.1 bcd	0.4 de	4.0 e	16.6 bc	2.9 h	197.4 d	1.2 ef	1021.8 b
HRSDAV07	76.6 fg	0.2 ef	6.0 ab	19.2 a	3.1 h	225.7 b	1.7 c	981.8 e
HRSDAV08	74.7 gh	0.9 b	6.7 a	15.6 cd	3.7 g	169.1 h	2.5 a	1040.5 a
HRSDAV09	79.5 cde	0.5 d	4.0 e	17.8 b	4.9 bc	226.2 b	1.4 d	942.4 f
HRSDAV010	78.0 ef	0.3 def	4.0 e	13.1 e	4.0 f	225.9 b	2.2 b	914.7 h
HRSDAV011	75.5 g	0.3 def	3.0 f	9.4 h	3.7 g	209.0 c	0.4 i	467.4 f
HRSDAV012	84.4 a	0.5 d	6.0 ab	10.9 fg	5.1 b	222.4 b	1.0 fg	781.3 l
HRSDAV013	72.9 h	0.9 bc	4.0 e	13.0 e	2.9 h	147.8 i	1.5 d	864.7 j
HRSDAV014	75.4 g	0.5 d	4.0 e	17.4 b	4.3 ef	220.5 b	1.1 f	924.8 g
HRSDAV015	74.8 g	0.1 f	4.0 e	12.9 e	3.5 g	181.4 f	1.5 cd	570.9 o
HRSDAV016	78.5 de	0.5 d	5.0 cd	10.8 fg	4.6 cde	191.4 e	0.7 h	742.8 n
Mean	78.37	0.53	4.66	13.2	4.05	203.5	1.29	857.24
F-Test	**	**	**	**	**	**	**	**
LSD (0.05)	1.76	0.221	0.74	1.29	0.31	5.16	0.207	7.79
CV (%)	1.4	25	9.6	5.9	4.6	1.5	9.6	0.5

** Significant at 0.01 level. The same letters in a column are not significantly different at P≤ 0.05; DMRT.

Analysis of variance showed highly significant (P≤0.01) differences in crude fat content among avocado genotypes (Fig. 2). The highest crude fat content (63.0%) was found in HRSDAV013 followed by HRSDAV08 (59.6%) and HRSDAV010 (59.2%), but the lowest (35.9%) was in HRSDAV04, followed by HRSDAV011 (36.9%).

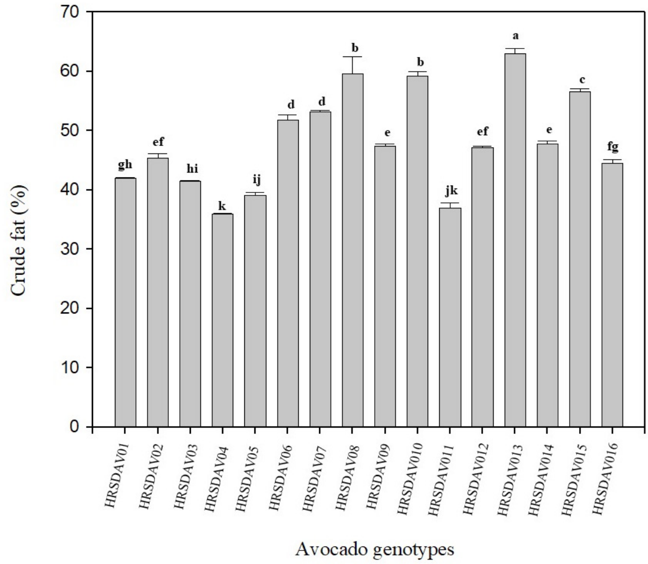

Fig. 2. Crude fat content (%) in fruit pulp of avocado genotypes. Values are the mean ± SE from three determinations. The same letters in the bars are not significantly different at P≤ 0.05; DMRT.

Highly significant (P≤0.01) differences in crude fiber content were observed among the avocado genotypes. HRSDAV03 showed the highest content of crude fiber (48.4%), followed by HRSDAV01 (39.0%), but it appeared statistically similar to HRSDAV05, HRSDAV07, HRSDAV08, and HRSDAV015 (Fig. 3).

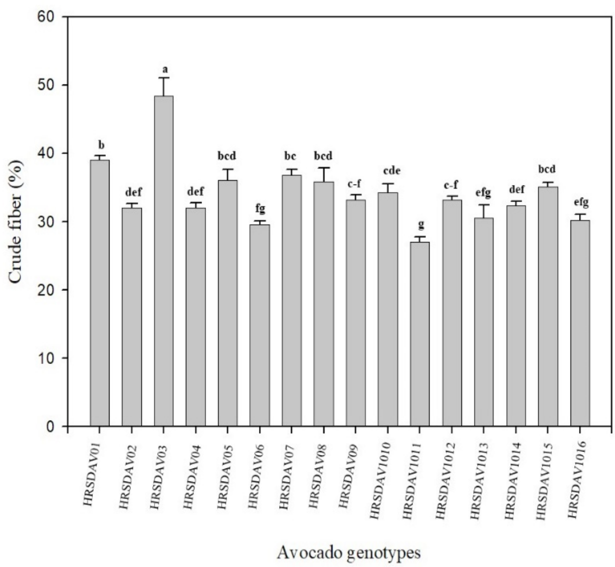

Fig. 3. Crude fiber content (%) in fruit pulp of avocado genotypes. Values are the mean ± SE from three determinations. The same letters in the bars are not significantly different at P≤ 0.05; DMRT..

4. DISCUSSION

Present study showed highly significant ($P \leq 0.01$) differences in fruit weight, fruit length and diameter, pulp weight, seed weight, pulp/fruit ratio, and seed/fruit ratio among avocado genotypes. Fruit weight is one of the most important indices in avocado (Schaffer *et al*. 2012) and significant variation in fruit weight in avocado genotypes was also published by previous researchers (Galvao *et al*. 2014; Lestari *et al*. 2016; Abraham *et al*. 2018; Ge *et al*. 2018; Poudel *et al*. 2018). Medina (1980) reported an average fruit weight of 718.0 g and 612.0 g in cultivars Fortuna and Collinson, respectively, in Brazil. Gomez-Lopez (2002) reported an average fruit weight of 364.0 g in the cultivar Barker. Variation in fruit weight is genotype dependent (Pino *et al.* 2004). In this study, fruit length ranged from 6.4 to 16.2 cm with the average of 10.7 cm. Crane (2008) measured the average fruit length 15.0 cm in West Indian avocadoes. In this study, HRSDAV08 had the longest (16.2 cm) fruit length. Medium size fruits, smooth fruit surface and rough cotyledon surface are the traits of West Indian avocado genotypes (Lestari *et al.* 2016). This study found the same traits in the fruits of genotype HRSDAV08, hence, it can be the West Indian genotype. Similarly, Lestari *et al.* (2016) also reported that fruit length varied from 6.2 to 23.5 cm. Ge *et al.* (2018) reported significant differences in fruit length and width in avocado accessions. This study observed the significant variation in fruit diameter and it ranged from 3.6 to 7.5 cm. But Lestari *et al.* (2016) reported that fruit diameter ranged from 5.8 to 12.1 cm in avocado genotypes. Variation in fruit size depends on genotype (Pino *et al*. 2004). Genotypes exhibited significant variation in pulp weight and similar result was reported by Poudel *et al.* (2018). This study showed the highest seed weight (59.6 g) in HRSDAV014, but Abraham *et al.* (2018) reported the seed weight between 25.0 and 125.0 g. Big seeds are characteristics features of Mexican and West Indian races while small seeds are typical characteristics of the Guatemalan race (Bergh & Lahav 1996). In this study, pulp/fruit ratio ranged from 53.8 to 87.5% which is close to the results of Lestari *et al.* (2016). Poudel *et al.* (2018) reported the maximum (62.3%) pulp/fruit ratio in genotype PAKAV002. In general, pulp makes up 65.0% of the fruit (Nayak *et al*. 2008). Genotypes HRSDAV014 and HRSDAV013 showed the highest seed/fruit ratio of 35.0% and 30.4%, respectively. Rouse and Knight (1991) reported that seed weight more than 25.0% of the total fruit weight was unacceptable while selecting avocado genotypes. Nayak *et al.* (2008) reported that seed makes up 20.0% of the fruit.

This study found the higher moisture content (84.4%) in HRSDAV012 than other genotypes which is very close to the findings of Morais *et al.* (2017) where they reported 83.3% moisture content in avocado pulp. But in the study of Mooz *et al.* (2012), they reported 79.3% moisture content in pulp. Surukite *et al.* (2013) found the moisture content between 67.6% and 73.6% in pulp, but this study revealed the moisture content in pulp between 30.8% and 84.4%. Moisture content is a good indicator for the economic importance of the fruits since it reflects solid contents and assesses its perishability (Vinha *et al*. 2013). Nnaji and Okereke (2016) reported differences in moisture content in different avocado varieties.

Reducing sugar varied from 0.1 to 1.4 g/100 g pulp with the average value 0.53 g/100 g. Sugar provides energy to the body and the content of reducing sugar also depends on variety (Nnaji & Okereke 2016). This study found the highest TSS in HRSDAV08 (6.7 °Brix), followed by HRSDAV03 (6.0 °Brix), HRSDV07 (6.0 °Brix), and HRSDAV012 (6.0 °Brix), but Burdon *et al.* (2007) reported the highest TSS (9.0 °Brix) in 'Hass' avocado in New Zealand. TSS also depends on cultivar, growing condition, ripeness and storage conditions (Ahmed *et al*. 2010). Proteins are complex nitrogenous substances that form an important part of living tissues.

Mooz *et al*.(2012) reported crude protein in the range of 1.1 to 1.8%, but this study found the crude protein in the range from 7.8 to 19.2%. Tripathi *et al.* (2011) also reported crude protein values of 0.7 ± 0.0 and 0.8 ± 0.0% in different cultivars and ripeness stage of papaya pulp. Morais *et al.* (2017) reported up to 12.5% crude protein in avocadoes pulp. In general, fruit values of crude protein are low because the fruits are not potential sources of proteins (Almeida *et al*. 2013). Similarly, Oluwole *et al.* (2012) reported very low total ash content (0.38%), but this study found the highest total ash content up to 6.4%. In contrast, Morais *et al.* (2017) reported 2.5% ash content in avocadoes. The ash content is significantly important in foods which accounts for the mineral constituents (Oluwole *et al*. 2012). Present study showed wide variation in phosphorous, iron and calcium in avocado fruits. Morais *et al.* (2017) reported 2.5 mg/100 g iron content in avocadoes and calcium content ranged from 24.4 to 207.7 mg/100 g. But this study showed calcium content in the range of 467.4 to 1040.5 mg/100 g.

Highly significant (P≤0.01) differences in crude fat and crude fiber were observed in avocado genotypes in this study. Vinha *et al.* (2013) reported 43.5% crude fat in avocadoes pulp, but this study found the maximum 63.0% crude fat. Lu *et al.* (2009) reported 25.0% crude fat in the pulp of 'Hass' avocados in California. Surukite *et al.* (2013) reported 4.8% crude fiber in ripe pulp. Contrary to this, present study showed the highest crude fiber (48.4%) in ripe pulp. Talabi *et al.* (2016) also reported the significant differences for crude fat and crude fiber in avocadoes at different processing methods. Besides, crude fat and crude fiber content of a fruit also depend on the variety (Ahmed *et al*. 2010).

5. CONCLUSION

The present study evaluated fruit physical and proximate compositions, and mineral contents of the 16 avocado genotypes at Dailekh. The results showed highly significant (P≤0.01) differences among the genotypes for their fruit morphological and chemical characters. Pulp/ fruit ratio showed the highest in HRSDAV05, HRSDAV03, HRSDAV09, HRSDAV07 and HRSAV015. But the lowest seed/fruit ratio was recorded in HRSDAV05, HRSDAV07, HRSDAV06, HRSDAV03 and HRSAV016. The variation in TSS, crude protein, total ash content, minerals content, crude fat and crude fiber were highly significant (P≤0.01) among the avocado genotypes. Thus, HRSDAV03, HRSDAV05, HRSDAV06, HRSDAV07 HRSDAV08, HRSDAV09 and HRSDAV013 showed better performance in economic traits and hence, these genotypes can be selected as potential parental lines for developing new variety in avocado.

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