ORIGINAL ARTICLE

Grain and starch properties of six durum wheat (*Triticum turgidum* L. var. *durum* Desf) varieties grown at Debre Zeit, Ethiopia

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(Received in revised form: May 20, 2011)

ABSTRACT

Six durum wheat grain varieties grown under uniform conditions at Debre Zeit, Ethiopia were evaluated. The kernel size (mm), length (KL), thickness (KT) and width (KW) were ranged from 7.20 to 7.69, 2.76 to 3.16 and 2.94 to 3.02, respectively. Amylose content ranged from *Boohai* (23.4%) to *Cocorit 71* (25.0%). The highest Falling number (FN, sec.) was associated with *Tob 66* (285.1) and lowest was for *Cocorit 71* (258.8). High FN is associated with low *alpha*-amylase activities of good pasta making potential. In this regard *Tob*, *Ude* and *Kilinto* are performed better. The wheat flour starches pasting temperature (Ti) varied form 64.5 to 66.7^{O}C. The apparent peak viscosity (PV, BU) ranged between *Kilinto* (492.7) and *Cocorit 71* (359.3). Lowest hot paste viscosity (HPV, BU), i.e. minimum viscosity during high temperature holding was for *Cocorit 71* (288.3) and highest was for *Tob 66* (397.3). The paste breakdown viscosity (BV) (PV-HPV, BU) varied between *Cocorit 71* (70.7) and *Kilinto* (108.0). The lowest cold paste viscosity (CPV) was for *Cocorit 71* (448.0) and highest was for *Tob 66* (545.3). The setback paste viscosity (SBV), (CPV-HPV, BU) varied between *Yerer* (137.7) and *Ude* (162.3). *Cocorit 71* had higher SBV than *Yerer*. Shear breakdown resistance are strong in *Cocorit 71*, *Yerer* and *Tob 66*. Amylose content and starch pasting curves indicates no *amylo*- and *waxy* starch traits in the varieties. Thus, the varieties are expected to have normal extrusion features in the pasta making with desirable quality of cooked pasta with subtle variations among themselves.

Keywords: Amylograph, Amylose, Durum wheat grain, FN, Pasting

INTRODUCTION

In the past in Ethiopia, phenotypic-genetic variations and environmental influence studies for disease resistance and yield on durum wheat have been reported (Dessalegn *et al*., 2003). In the durum wheat grain quality evaluations for pasta making, degree of kernel vitreosity, plumpness, protein content and its functionality, yellow pigment levels are widely considered (Sissions, 2004). In line with this, some works on grain and flour quality factors mainly on protein functionality and its genetic variability for some durum wheat varieties grown in Ethiopia are available (Bechere *et al.*, 2002; Dessalegn *et al*., 2003). Abebe *et al.* (2008) reported gluten strength (SDS sedimentation volume and farinogram data) as better for *Kilinto* and *Cocorit 71* followed by *Ude* among the six-durum wheat varieties considered in this study.

The protein content ranged 10.8% (*Cocorit 71*) to 12.7% (*Tob 66*). The vitreosity percentages were found above the minimum requirements of the pasta industry except is inferior for *Cocorit 71*. The yellow pigment was high for *Tob 66* and *Ude* and was least for *Cocorit 71*.

Starch accounts about 68% in whole durum wheat grain (Samaan *et al*., 2006) and about 80% in semolina on dry matter basis (Yue *et al*., 1999). Starch functionality is important in the durum wheat grain quality evaluation for pasta products processing (Vignaux *et al*., 2004; Gianibelli *et al*., 2005 and Soh *et al*., 2006), though at large grain protein content and its functionality, grain hardness, vitreousness and yellow pigment levels are widely studied. To this date information on starch properties and its functionality in relation to pasta making on the durum wheat varieties cultivated in Ethiopia is virtually absent. In view of this, in this work, kernel size, amylose/amylopectin ratio, falling number and flour starch pasting properties of six-durum wheat varieties grown under uniform conditions were evaluated.

MATERIALS AND METHODS

Samples

The varieties: *Cocorit 71*, *Boohai*, *Kilinto*, *Ude*, *Yerer* and check *Tob 66* used in the study were developed both from exotic germplasm and indigenous landraces and are recommended for different agro-ecological zones of Ethiopia. The varieties were grown as described elsewhere (Abebe *et al*., 2008) during the main growing season of 2005 to 2006 under rain-fed of uniform condition at Debre Zeit (8° 44' N, 39° 02' and 1900 m. a. s. l, 851 mm mean annual rainfall, 17^{O}C mean day temperature and on pellic vertisol soil), Ethiopia.

Average kernel size

Kernel size is one of the main grain physical properties dictating primary processing characteristics of durum wheat grain (Chassery, 1994). Random grain samples from each variety were sieved over 2.8 mm slots and dockages were removed. Average kernel length was determined using a digital calliper (± 0.01 mm) by aligning 10 sets of 25 kernels end to end (brush to germ) putting crease down (Schuler *et al*., 1994). Average kernel width was measured using similar sample sizes by placing side by side crease down with adjacent kernels at contact point will be at their widest points. Average kernel thickness was also measured in similar manner by placing them with edge of the kernels.

Moisture content

Cleaned and dockage free representative grain sample from each variety was milled (500 μm) by laboratory hammer mill (Christy and Norris Ltd. Process Engineers, Suffolk, England). Moisture content was determined by taking approximately 3 g flour samples drying in an air draft oven (AACC, 2000 method 44-15A).

Amylose/Amylopectin ratio

Amylose/amylopectin ratio was analyzed by taking 30 to 40 mg flour by amylose-iodine binding of blue colour absorbance measurement at 620 nm using UV-Visible spectrophotometer (Cecil CE4001, Cecll Instruments - Milton Technical Centre - Cambridge, England) (Charastil, 1987). Amylose (%) was estimated from standard (0 to 100% amylose) calibration curve prepared from 70% *amylo*-maize and 99% amylopectin. Normal maize starch (28% amylose) was used as a control.

Falling number

Sample (250 g) was milled with a laboratory cyclone mill (Wisper Mill, Pocatello Idaho, USA) fitted with 1 mm sieve. In order to get a sample close to flour, it was sieved for 15 min. on a shaker fitted with 132 μm sieve. Falling number was determined on a 7 g sample ground wheat flour (14% moisture basis) according to ICC standard number 107/1 (ICC, 2000) using Falling Number 1500 (Perten Instruments AB, Sweden).

Flour starch pasting

This was analyzed on 14% dry matter basis (db) by using Micro Visco-Amylograph® (Micro Visco-Amylograph®, Brabender Measurement and Control Systems, Duisburg, Germany). The amylograph was programmed at 30^{O}C for 1 min., heated to 90^{O}C at a rate of 7.5^{O}C per min., held at 90^{O}C for 5 min. and cooled to 50^{O}C at the rate of 7.5^{O}C per min. From the resulting pasting curve, temperature at initial viscosity increase (T_i) which is the minimum temperature required to cook a starch, peak viscosity (PV) a measure of viscosifying tendency, hot paste viscosity (HPV) (minimum viscosity during the highest temperature holding), breakdown viscosity (BV) (PV-HPV), cooled paste viscosity (CPV) (viscosity at the end of cooling period) and setback viscosity (SBV) (CPV-HPV) were determined by visco-amylograph software for windows version 72300 (Brabender® Measurement and Control Systems, Germany).

Statistical analysis

At least a triplicate data were analyzed (Gomez and Gomez, 1984) by one-way analysis of variance (ANOVA) using SAS statistical software (SAS Institute Inc., Cary, NC). Means were then compared at $p < 0.05$ using Fisher's least significant difference (LSD) test. Pearson's correlations were estimated at $p < 0.01$ and $p < 0.05$.

RESULTS AND DISCUSSIONS

Kernel size

Differences in average kernel length (KL), kernel width (KW) and kernel thickness (KT) of the varieties are shown in Table 1. The KL of the varieties varied between 7.20 mm (*Cocorit 71*) and 7.69 mm (*Ude*). The KL of *Ude* was higher ($p < 0.05$) than all the varieties except *Kilinto*. No significant difference ($p > 0.05$) in KL was observed between *Ude* and *Kilinto*, between *Kilinto* and *Yerer* and among *Cocorit 71*, *Boohai*, *Yerer* and *Tob 66*. The lowest kernel thickness (KT) was that of *Cocort 71* (2.76 mm) and *Ude* (2.76 mm) while the highest was for *Boohai* (3.16 mm). *Boohai* (3.16 mm), *Tob 66* (3.13 mm) and *Kilinto* (3.13 mm) are significantly higher in their KT than *Yerer* (2.81 mm), *Ude* (2.76 mm) and *Cocorit* (2.76 mm). No significant differences were observed among *Boohai*, *Tob 66* and *Kilinto*; and *Yerer*, *Ude* and *Cocorit*. However, no significant difference ($p > 0.05$) was observed for average kernel width (KW) among the varieties. The KW had ranged from 2.94 mm for *Yerer* to 3.02 mm for *Tob 66*. Knowledge on the kernel size (average grain length, width, and thickness) of a given lot is important (Chasseray, 1994). It helps in choosing screens in the grain cleaning operations, in the adjustments of grain feeding rate at the beginning of the equipment chain and milling rollers cylinder gaps adjustments during grain milling operations. The mean KL, KW and KT of 16 durum wheat varieties grown in two locations of southern Italy were reported to range from (mm) 6.65 to 7.61, 2.57 to 2.97 and 2.65 to 2.98 mm, respectively (Troccoli and Di Fonzo, 1999) and the mean squares of these traits had highly significant relation to the varieties. In this study, the varieties kernel dimensions were apparently higher than the 16 Italian varieties (*Balsamo*, *Cirillo*, *Cosmodur*, *Creso*, *Crispiero*, *Messapia*, *Fenix*, *Flavio*, *Gianni*, *Ofanto*, *Radioso*, *Simeto*, *Travoliere*, *Tresor*, *Nudura* and *Valbelice*). The local varieties were appeared more plumb than those reported by Troccoli and Di Fonzo (1999). No significant correlation was observed among the three size parameters (Table 3), however, that of kernel length and kernel width was higher.

Amylose/Amylopectin ratio

The amylose content ranged between 23.38% (*Boohai*) and 25.03% (*Cocorit 71*) and there was no significant difference ($p > 0.05$) among the varieties (Table 1). The amylose % of maize starch control analyzed along was 28.79%. Amylose/amylopectin ratio is a useful descriptor of starch composition and functionality because starch properties like gelatinization, pasting, starch breakdown, starch components solubility, gelation, retrogradation characteristics and extrusion cooked pasta characters are influenced by it (Yue *et al.*, 1999; Sissons and Batey, 2003; Samaan *et al.*, 2006). The amylose content in the starch granule is determined by varieties genetics with subtle influence by the growing environments (Watanabe *et al.*, 1998). Among 665 durum wheat accessions

Watanabe *et al*. (1998) reported, 517 had amylose between 25 and 35%. Amylose in the range from 15.5 to 22.8% was also reported for some durum wheat varieties (Sissons and Batey, 2003). Review by Bultosa (2003) shows that in the normal cereal starches amylose comprises 18 to 33%, whereas amylopectin is from 72 to 82% of the granule. In the pasta making technology, durum wheat amylose content between 24 to 28% was reported preferred (Vansteelandt and Delcour, 1998) than *amylo*- (Gianibelli *et al*., 2005; Soh *et al*., 2006) or *waxy*-(Vignaux *et al*., 2004) type starches. In some work (Soh *et al*., 2006) high amylose 32 to 44% was described better in dough extensibility and cooked pasta firmness stability. A substantially reduced amylose percentage (substitution with *waxy* starches) than the normal range ends up into sticky pasta of inferior pasta cooked firmness (Gianibelli *et al*., 2005). In the *waxy*-type starch containing durum wheat, because of poor bran and endosperm separation on milling, a reduced yield of semolina of high in -ash, -starch granules damage and -α-amylase activity was reported (Vignaux *et al*., 2004), all these are linked to poor pasta making features. The amylose contents observed in the current durum wheat varieties are regarded in the normal range though is apparently low when compared to the data of Watanabe *et al.* (1998), because in part the analysis was made on flour, which is usually has subtle less value than analysis based on extracted starches (Mahmood *et al*., 2007). The flour starches amylose of the six durum wheat varieties under this study had ranged from 23.38 to 25.03% indicating no *amylo*- or *waxy*- type starch traits. Thus, the varieties are expected to have normal extrusion characteristics expected from normal durum wheat starch granules.

Falling number (FN)

The highest falling number (FN, sec.) was obsreved in *Tob 66* (285.11) and lowest was for *Cocorit 71* (258.77) (Table 1). The FN scored by *Tob 66* is significantly greater than that of *Yerer*, *Boohai* and *Cocorit 71*. Similarly, the FN scored by *Boohai* is considerably greater than *Cocorit 71*. There was no marked variation among *Kilinto*, *Ude*, and *Tob 66* and also among *Boohai*, *Kilinto*, *Ude* and *Yerer* in their FN. An increase in the α-amylase enzyme activity in the grain is associated with the process of sprout damage and germination (Gooding and Davies, 1997). The falling number measures time (sec.) required the spindle to fall a set of distance by gravity through gelatinized viscosity of starch suspension under liquefaction by influences of α-amylase enzymes in a water bath (100^{O}C) (Mares and Mrva, 2008). Thus, variations in the FN of the varieties could be a reflection of the α-amylase activity variations, since α-amylase activity in the flours are inversely related to the FN. The α-amylase activity level in *Tob 66* was lowest and highest was in *Cocorit 71*.

Some wheat varieties suffer from an inherent excessive premature α-amylase activity (Mares and Mrva, 2008). In such wheat, with minor microclimate change, sprout damage can be triggered. Increased α-amylase activity can develop in a standing crop of wheat with high level of rainfall close to harvest at its physiological maturity or by moisture abuse after harvest. If crop is lodged in a humid microclimate, germination can be also encouraged within the mat of laid straw and ears. These effects are pronounced in some varieties and with an increase in the nitrogen application (Gooding and Davies, 1997). Though some lodging was observed on *Tob 66* and *Kiliinto* right from the 53th and 60th day after planting, these varieties scored higher FN. In these varieties, probably the inherent α-amylase activity is low or may be resistant to conditions that induce sprouting (Gooding and Davies, 1997). In part also probably kernels affected by logging were removed on cleaning because of their light mass. If durum wheat gets sprout damaged, it will lead to uneven hydration and extrusion, uneven strand stretching on pasta drying and high potential for checking and cracking upon pasta storage and because of this, most industry demands falling number (FN) of above 300 sec. (Sissons, 2004). The typical FN quality data for the consecutive three grades of Canadian West Amber Durum Wheat (CWAD) for 2000 to

2001 was 410, 390 and 280 sec. (Sissions, 2004). With this classification, only Tob 66 and Kilinto can lie in the grade number three of CWAD. However, the common FN threshold set by UK millers is 250 to 300 sec. for pasta making (Gooding and Davies, 1997), and this puts all the six-durum wheat varieties within the required range of better character in Tob 66 followed by Kilinto and Ude.

Pasting properties

The pasting curves (whole meal sample) of the varieties are shown in Fig. 1. Significant difference ($p < 0.05$) in the pasting temperature (T_i) was observed only between the lowest *Ude* (64.5^{O}C) and the highest *Boohai* (66.7^{O}C) (Table 2). The result shows that T_i of the varieties was slightly less than for bread wheat reviewed by Bultosa (2003) and comparable to the normal pasting temperatures for durum wheat starches (Sissons and Batey, 2003). The result also shows that T_i for the durum wheat varieties is less than the Rapid Visco Analyzer Unit (RVU) pasting temperature (T_i) for tef (74^{O}C) and maize (74.1^{O}C) starches (Bultosa *et al*., 2002), because temperate cereal starches had lower gelatinization temperatures than tropical cereal starches. The T_i of *Cocorit 71*, *Boohai*, *Kilinto*, *Yerer* and *Tob 66* were lower and this indicates that the starches in these varieties had fairly lower cooking temperature.

Peak viscosity (PV, BU) was ranged between *Kilinto* (492.67) and *Cocorit 71* (359.33). The PV of *Kilinto* (492.67), *Boohai* (484.67), and *Tob 66* (484.67) were significantly ($p < 0.05$) higher than that of *Ude* (441.67), and *Ude* also had higher PV than *Cocorit 71* (359.33). The high PV was associated with lower apparent and total amylose contents (Shibanuma *et al*., 1996), low sprout damage of low alpha-amylase activities (Samaan *et al.* 2006; Mares and Mrva, 2008) in wheat starches. This study indicates that *Kilinto* had high viscosifying tendency and the least was for *Cocorit 71*. Negative ($p < 0.05$) correlation was exhibited between amylose content and PV (Tables 1 and 2), i.e., varieties with high amylose content like *Cocorit 71* exhibited lowest PV. A durum wheat starch with high swelling and high peak viscosity were reported to suffer from pasta cooking losses, if there is poor trapping nature of proteins for starches (Yue *et al*., 1999; Sissons and Batey, 2003; Samaan *et al*., 2006). This is because as the starch gets swelled and gelatinized on heating in water, there are more starch molecules exudations (Gianibelli *et al*., 2005). Thus the cooking loss from the varieties of high PV like *Kilinto*, *Boohai* and *Tob 66* in the pasta to be made may be probably high if trapping nature of proteins are poor.

On the other hand pasta cooking losses are also high in durum wheat of high α-amylase activity caused by sprout damage or by inherent high α-amylase activity (Samaan *et al*., 2006; Mares and Mrva, 2008) and obviously a substantial reduction in the PV is thus linked to poor pasta quality products. The time to peak viscosity (P_t, min) for all the varieties was virtually identical and ranged between 3.36 (*Yerer*) and 3.60 (*Tob 66*) (Table 2). The hot paste viscosity (HPV, BU) of *Cocorit 71* (288.33) was lowest and highest was for *Tob 66* (397.33). The pasting of *Tob 66*, *Yerer* and *Kilinto* showed significantly ($p < 0.05$) higher HPV than *Ude* and *Cocorit 71*. The HPV exhibited by *Ude* and *Boohai* also were considerably higher than that of *Cocorit 71*. However, there was no significant difference among the HPV of *Boohai*, *Kilinto*, *Yerer* and *Tob 66*, and also between those of *Boohai* and *Ude*.

Table 1. Grain size, amylose (%) and falling number (FN) of six durum wheat varieties

Variety	Kernel size (mm)*			Amylose (%)	FN (sec)
	KL	KT	KW		
Cocorit 71	7.20[c]±0.09	2.76[b]±0.06	3.00[a]±0.13	25.03[a]±2.34	258.78[c]±5.98
Boohai	7.25[c]±0.23	3.16[a]±0.16	2.95[a]±0.10	23.38[a]±4.39	272.00[b]±2.60
Kilinto	7.65[ab]±0.06	3.13[a]±0.08	3.01[a]±0.03	24.72[a]±1.65	281.00[ab]±6.00
Ude	7.69[a]±0.16	2.76[b]±0.02	2.95[a]±0.21	23.57[a]±1.86	273.44[ab]±9.10
Yerer	7.41[bc]±0.14	2.81[b]±0.08	2.94[a]±0.10	23.39[a]±2.82	272.56[b]±9.96
Tob 66	7.29[c]±0.17	3.13[a]±0.05	3.02[a]±0.09	24.04[a]±2.45	285.11[a]±0.77
Mean	7.42±0.23	2.96±0.20	2.98±0.12	24.02±2.39	273.81±10.16
LSD (5%)	0.2694	0.156	0.2177	4.864	11.736
CV(%)	2.04	2.96	4.11	11.381	2.409

Values are mean ± SD of 3 samples; *On 12.5% moisture basis; Values within the same column with different letters are significantly different ($p < 0.05$); Where: KL= kernel length; KT= kernel thickness, KW= kernel width and NS = not significant

Table 2. Pasting properties of flours from six durum wheat varieties

Variety	T_i (°C)	PV (BU)	P_t (min)	HPV (BU)	BV (BU)	CPV (BU)	SBV (BU)
Cocorit 71	64.63[ab]±0.29	359.33[c]±17.50	3.36[a]±0.34	288.33[c]±19.43	70.67[b]±3.51	448.00[b]±21.28	157.00[ab]±2.65
Boohai	66.70[a]±2.79	484.67[a]±37.23	3.42[a]±0.46	377.67[ab]±34.93	107.00[a]±6.24	519.67[a]±35.36	143.33[bc]±4.16
Kilinto	65.40[ab]±0.36	492.67[a]±25.74	3.58[a]±0.36	384.67[a]±22.94	108.00[a]±20.88	532.33[a]±19.55	147.67[bc]±8.96
Ude	64.50[b]±0.35	441.67[b]±4.04	3.51[a]±0.21	339.33[b]±5.51	102.33[a]±9.29	501.67[a]±5.03	162.33[a]±0.58
Yerer	66.33[ab]±0.21	478.67[ab]±30.86	3.36[a]±0.34	393.33[a]±31.01	85.33[ab]±20.40	531.00[a]±33.06	137.67[c]±5.69
Tob 66	65.77[ab]±0.31	484.67[a]±11.59	3.61[a]±0.34	397.33[a]±18.77	87.33[ab]±8.39	545.33[a]±22.23	148.00[bc]±14.73
Mean	65.56±1.29	456.94±52.05	3.47±0.31	363.44±44.52	93.44±17.84	513.00±38.97	149.33±8.99
LSD (5%)	2.08	42.71	NS	42.77	23.65	44.17	13.67
CV(%)	1.79	5.25	10.07	6.61	14.23	4.84	5.15

Values are mean ± SD of 3 samples; Values within the same column with different letters are significantly different ($p < 0.05$). Where T_i = temperature at the initial viscosity increase; PV = peak viscosity; P_t = time to peak viscosity; HPV = hot paste viscosity; BV = break down viscosity; CPV = cold paste viscosity and SBV= set back viscosity

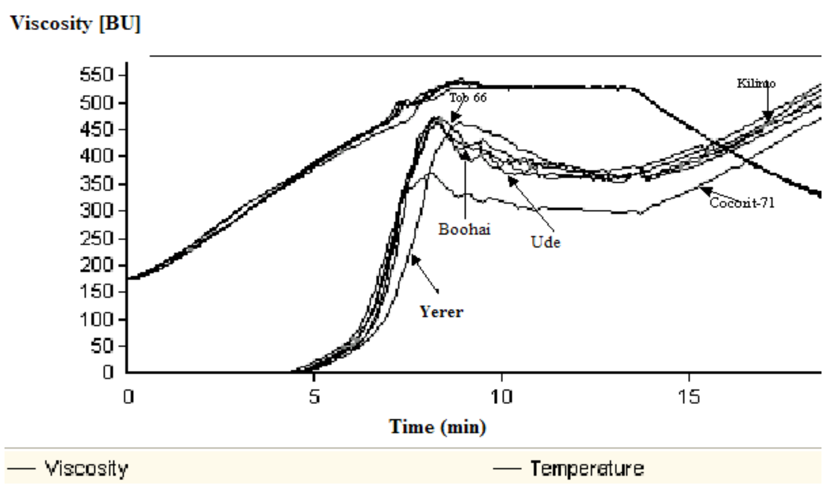

Figure 1. Amylograph flour starch (14 % db) pasting curves for six durum wheat varieties.

Breakdown viscosity (BV, BU) had varied between 70.67 (*Cocorit 71*) and *Kilinto* (108.00). The BV of *Boohai*, *Kilinto* and *Ude* were considerably higher than that of *Cocorit 71*. No significant differences ($p > 0.05$) in BV among *Boohai*, *Kilinto*, *Ude*, *Yerer* and *Tob 66* and also among *Cocorit 71*, *Yerer* and *Tob 66* were observed. In the normal native starch granules, BV is dependent on macro-molecular structure of the amylose/amylopectin (Shibanuma *et al*., 1996), starch granule associated lipids (Morrison, 1995) and proteins (Baldwin, 2001), degree of amylopectin phosphorylation (Bultossa *et al*., 2002) and on the level of α-amylase activity (Mares and Mrva, 2008). Low BV is related to shear tolerance nature of the starch granule and in part important in the extrusion operation. In this study Cocorit *71* had high shear tolerance and least is for *Kilinto* and this also is in part influenced by the fact that the PV of *Cocotit 71* is the least and that of *Kilinto* is the highest. The result indicates that in the extrusion shear resistance varieties *Cocorit 71*, *Yerer* and *Tob 66* would be expected to perform better.

The lowest cooled paste viscosity (CPV, BU) was for *Cocorit 71* (448.0) and highest for *Tob 66* (545.33). Only *Cocorit 71* had a significant (p < 0.05) lower CPV than the rest varieties and no significant variation was observed among the remaining. Setback viscosity (SBV, BU) exhibited by the varieties had varied between 137.67 *Yerer* and 162.33 *Ude*. The SBV of *Ude* was considerably higher than for *Boohai*, *Kilinto*, *Yerer* and *Tob 66*. The *Cocorit 71* also had significantly higher SBV than *Yerer*. However, no significant variation was observed between the SBV of *Cocorit 71* and *Ude*, among the SBV of *Cocorit 71*, *Boohai*, *Kilinto*, and *Tob 66*, and also among *Boohai*, *Kilinto*, *Yerer* and *Tob 66*. Varieties: *Boohai*, *Kilinto*, *Yerer* and *Tob 66* would be expected to behave slow gelation character, since the lowest SBV is the lowest gelation tendency of amylose.

The FN showed a positive correlation with peak viscosity (r = 0.58), hot paste viscosity (r = 0.60) and cold paste viscosity (r = .61). This agrees with decrease in FN, an increase in α-amylase activity that negatively influences the viscosity of the hot flour starch pastes (Gooding and Davies, 1997). Among the kernel size parameters, kernel thickness had significant correlation with the FN (r = 0.55) and few of the pasting properties-PV (r = 0.53) and HPV (r = 0.49). Kernel length showed negative correlation with Ti (r = -0.51).

The pasta cooking loss from the varieties of high PV namely *Kilinto*, *Boohai* and *Tob 66* would be probably high if the trapping nature of proteins for amylose on swelling and gelatinization becomes poor. Varieties *Cocorit 71*, *Yerer* and *Tob 66* were superior in terms of resistance toward starch breakdown during extrusion. Relatively pasta products from *Yerer*, *Boohai*, *Kilinto* and *Tob 66* probably would be expected stored for longer duration because of lower setback viscosity.

CONCLUSIONS

Information on durum wheat grain sizes is important for durum wheat grain processors and grain breeders since this character influences the grain primary processing activities. Both amylose content and the amylograph starch pasting curves analyzed showed no *waxy* or *amylo*-type starch traits in the varieties. Thus the starch in the six varieties would be expected to have normal extrusion properties in the pasta making process with subtle variations among themselves. Eventhough difficult to get single variety that fulfils all quality requirements for pasta products, the study showed that *Tob 66*, *Kilinto* and *Yerer* were better in most predictive quality features evaluated. The pasta processors can also benefit from blending of the varieties to overcome the challenge. Future study in this line is recommended to focus on further characterization of the varieties and accessions for sprout resistance and starch functionalities. For promising varieties among accessions, after scaling up of the production, characterization of the pasta by pilot processing is also important to get complete information.

ACKNOWLEDGEMENTS

Research expense by Agricultural Research and Training Project (Ethiopian Government), study and facilities provision by Haramaya University, study leave permit to the first author by Melkassa Agricultural Research Centre; the Debre Zeit Agricultural Research Centre and the National Durum Wheat Improvement Programme for providing the seeds and land to grow the varieties; and the Kality Food Share Company and the International Livestock Research Institute for use of some laboratory facilities are sincerely acknowledged.

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