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Physicochemical and pasting properties of starch extracted from eleven sweetpotato varieties

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Physicochemical and pasting properties of starch extracted from eleven sweetpotato varieties were evaluated. Relationships between starch properties were determined using correlation analysis. Significant differences were revealed among the physicochemical properties such as amylose, pH, granule size and size distribution. According to the Rapid visco analyzer (RVA) viscosity profiles, all starches exhibited a type A profile which is characterized by high peak viscosity followed by major breakdown. However, significant differences were observed in individual pasting parameters such as pasting time, hot paste viscosity, cold paste viscosity, stability ratio, setback ratio and breakdown. The results revealed that variety has an effect on composition and pasting properties of sweetpotato starch. Correlations developed in this study were useful in predicting starch functionality when applied in food industry.

Keywords: Sweetpotato starch, physicochemical, pasting, viscosity.

INTRODUCTION

Sweetpotato (*Ipomoea batatas* L.) is one of the world's most important, versatile, but under exploited food crops. Sweetpotato is a high yielding crop with wide adaptation and high resistance to drought (Lu et al.,2006). In Malawi, utilization of sweetpotatoes has largely been limited to boiling and roasting because they are bulky, perishable and lack appropriate processing technologies (Moyo et al., 1998). Storage of sweetpotato tubers is usually in pits using ash or in sacks (especially in the lower part of Malawi). However, pit storage has been found to be effective for at least four months and is constrained by sweetpotato weevil damage, rotting and rodents (Moyo et al., 2004). In addition, the use of ash in sweetpotato storage has been found to produce unattractive and low market value tubers due to shrinkage (Mbeza et al., 1997). Thus, there is need for continued effort to develop sweetpotato production towards improved processing technology and value

added products.

Commercial utilization of sweetpotato for industrial raw materials like flour and starch is non-existent although it has the potential of adding value to the produce and helping create new domestic and export market niches for new products. However, increase in utility would also depend on thorough understanding of the effect of processing on their properties and functionality.

Sweetpotato roots contain approximately 70% starch of the total dry weight (Lu and Sheng, 1990) and physicochemical properties of sweetpotato starch differ depending on botanical source. These differences affect the quality of products made from sweetpotato starch (Chen et al., 2003a). It is for this reason that suitable varieties are needed for the production of sweetpotato starch for the processing of high quality food products. Starch properties of interest include, among others, amylose content, granule structure, gelatinization and pasting behaviour. Amylose content of sweetpotato starch is considered to be one of the most important factors influencing the cooking and textural qualities of

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whole storage root, and quality of sweetpotato starch-based foods (Collado et al., 2001). Starch granule size and distribution affect cooking time, starch noodle quality and modified starch quality (Chen et al., 2003b). Starch pasting properties influence sweetpotato eating quality and noodle quality, and are also directly responsible for starch industrial uses (Collado et al., 2001). However, a lot of studies on relationships among starch quality parameters showed that even where correlation coefficients were significant, they might not always be consistent because of the wide diversity of sweetpotato genotypes, and the complexity of the inheritance of quality parameters (Lu et al., 2006). Hence testing for every important parameter of sweetpotato starch quality becomes a necessity.

The great versatility of sweetpotato starch as a base for many commercial products points out the need for a better understanding of its functional properties. This study, therefore, aimed at characterizing starch to get information about the potential of locally available sweetpotato starch in the food industry. In attempting to do this, important starch quality characteristics such as physicochemical and RVA pasting parameters were determined in samples of eleven sweetpotato varieties to get a better understanding of sweetpotato starch functionality when applied in various food products.

MATERIALS AND METHODS

Materials

Eleven sweetpotato varieties Kenya, Mugamba, Zondeni, Salera, Semusa, Lunyangwa, LU96/274, LU96/303, LU96/304, LU96/334 and LU96/374 were planted at Kandiyani experimental site in Lilongwe. Six of the varieties (Kenya, Mugamba, Zondeni, Salera, Semusa, Lunyangwa) were released varieties while the other five (LU96/274, LU96/303, LU96/304, LU96/334 and LU96/374) were unreleased but showed great potential of being high yielding. The experimental plots were co-supervised by Southern Africa Root Crops Research Network (SARRNET). Harvesting of all the varieties was carried out four months later and within a 48 hour period. Twenty medium-sized storage roots per variety were randomly selected for starch extraction.

Tuber dry matter

Dry matter was determined gravimetrically according to the method of AOAC (2000).

Starch content

Starch content of raw tuberous roots was determined following the method of Noda et al (1992), with the sulphuric acid used in this method having a lower concentration (0.005N) to avoid structural breakdown of other carbohydrate components. After hydrolysis, the contents were vacuum filtered through Whatman No. 40 filter paper.

Filtrates were analyzed for glucose, by the phenol–sulfuric acid method and concentrations determined against a glucose standard. Starch content of the samples was estimated by multiplying the glucose content by the glucose equivalent of 0.9.

Starch extraction

Starch extraction was carried out within 24 hours of harvesting based on the method of Brabet et al (1998). Freshly harvested sweetpotato tubers were thoroughly washed, peeled and macerated in a heavy duty grater into a bowl of water and filtered through a muslin cloth. The residue was then re-suspended in tap water (1:2 v/v) and filtered in the same way. The two filtrates were pooled and passed through a 250 µm sieve. Starch was allowed to settle for 3 hours at room temperature (20-24°C) and the supernatant was discarded. The starch was then re-suspended in tap water and filtered through a 75 µm sieve and left to settle for 2 hours. This step was repeated three times replacing tap water with deionised water for the two last washings.
Recovered starch was dried in a DV 600 hot air oven (Yamato, Japan) at 40-45°C for 24 hours. Dried starch was then ground in a laboratory blender (Waring, USA) to pass through a 250 µm sieve and stored in sealed polyethylene (Ziploc[TM]) bags at 6°C. Extractable starch was calculated as a ratio of grams (g) starch at standard 14% moisture content per 100 g fresh roots.

Physicochemical properties of starches

Moisture content of the starches was determined by drying 2 g of sample in a DV 600 box oven (Yamato, Japan) for 1 hour at 130°C. pH was determined using a 2500 series pH meter (Oakton, Singapore) after standardising with buffer solutions of pH4 and pH9. Determination of phosphorus also followed the standard titrimetric method AOAC (2000).

Starch granule morphology

Starch granule morphology was studied by staining 0.01% granule suspensions (1 g of starch into 100 ml distilled water) with 0.1% iodine solution. Granule size was measured and photographed using an SZ6045 zoom stereo microscope (Olympus Optical Co, Japan) fitted with a calibrated eyepiece to calculate the average and range of the granules (Umerie and Ezenzo, 2000).

Amylose content

Amylose content of the starch was measured by complex formation according to a method described by Chrastil (1987). Absorbance of the developed colour was read at 620 nm using a Spectronic 601 spectrophotometer (Milton Roy Co, USA).

Starch pasting properties

Starch pasting properties were determined by subjecting a starch suspension of 2 g starch in 25 ml distilled water to a controlled heating and cooling cycle under constant shear using a Rapid Visco Analyser – 3 series (Newport Scientific Pvt Ltd, Australia). Pasting parameters were measured over time. These parameters included onset of pasting to peak viscosity (P_{time}); temperature at which peak viscosity was reached (P_{temp}); peak viscosity (PV); viscosity at the end of the holding time at 95°C or hot paste viscosity (HPV) and

viscosity at the end of the holding time at 50°C or cold paste viscosity (CPV). From these parameters, breakdown, stability ratio and setback ratio were calculated.

Statistical analysis

Statistical Package for Social Scientists (SPSS, version 15.0) was used for statistical analysis. Differences between samples in each item were tested using analysis of variance (ANOVA) and Duncan's Multiple Range as a post-hoc test when the analysis of variance indicated significant differences in the means. Data for starch properties were subjected to Pearson's product-moment correlation coefficient tests. A significance level of $P < 0.05$ was used throughout the study.

RESULTS AND DISCUSSION

Root dry matter and starch content

Root dry matter and starch content of the eleven varieties varied significantly ($P≤0.05$). Root dry matter ranged from 29 to 39.07% and starch content ranged from 54.72 to 95.09% on dry matter basis   (Table 1). These values are within the ranges reported in literature. Sweetpotato dry matter values of between 13.6 and 48.2% have been reported. Sweetpotato dry matter is composed of starch (70%), total sugar (10%), total protein (5%), lipid (1%), ash (3%) and fibre (10%) (Bradbury and Holloway, 1988). However, this composition varies widely because of differences in variety, soil type, pest and disease incidences and cultivation practices (Woolfe, 1992).

Extractable starch ranged from 39.62 (LU96/374) to 57.26% (Zondeni) on dry matter basis. A highly significant positive correlation was found between starch yield and tuber dry matter ($r=0.793$, $p≤0.01$). Brabet et al (1998) reported similar results in their study of 106 sweetpotato varieties. Thus root dry matter which is cheaper, simpler and faster to determine can be used to predict and select sweetpotato varieties with high extractable starch. Low extractability in LU96/334 and LU96/374 could possibly be attributed to some of the tubers that were damaged by weevil infestation.

Total starch in the eleven varieties also varied significantly ($p≤0.05$), from 54.72 to 95.09% on dry matter basis. These values were also found to be in line with the findings of Woolfe (1992) and Brabet et al (1998). However, there was no correlation between total starch and starch yield. This is because starch extraction is not 100% efficient in any case. Extraction is said to depend on softness of the roots on harvest. However, Rahman et al (2003) showed that insufficient homogenization led to loss of starch into the fibre. Increased

homogenization on the other hand, did not bring about the same increase in starch yield in the different varieties. This would suggest that the manner in which starch is held in the fibre is not the same for different varieties. For some varieties, starch is held more strongly than in others. Therefore, extractability is a more important criterion in the choice of variety for starch extraction rather than starch content (Rahman et al., 2003). Sweetpotato variety plays an important role in starch processing, thus processors of sweetpotato starch should pay attention to variety selection.

Properties of starch extracted from sweetpotatoes

Chemical properties

Physicochemical characteristics of the isolated native starches are presented in Table 2. Moisture content of the starches varied significantly ($p≤0.05$) from 6.83 (LU96/374) to 12.4% (Semusa). The differences in moisture could be attributed to differences in variety and also to differences in the extent of drying (Chen et al., 2003a).

pH of the extracted starches varied significantly ($P≤0.05$) from 4.33 (LU96/374) to 5.57 (Salera). Starch pH has been speculated to have some effects on starch functionality. High pH starches have been found to have increased solubility. This is due to increased hydrophilic characters of the starch at these pH values (Adebowale et al., 2005). On the other hand, pH values of between 5 and 7 are said to generally stimulate retrogradation. This is because salts of monovalent anions and cations, which have been found to retard retrogradation, are generally absent (Chen et al., 2003a).

A significant difference ($p≤0.05$) was observed in amylose content among the eleven varieties. Semusa and Salera showed the highest (18.6%) and lowest (10.5%) amylose contents respectively. These values are in line with those reported in literature of between 8.5 to 38% (Tian et al., 1991; Woolfe, 1992; Chen et al., 2003a). Phosphorus content showed no significant difference ($p≤0.05$) among the samples except for Lunyangwa, ranging from 0.03 (Zondeni) to 0.76 mg/g (Lunyangwa). Phosphorus has been found to negatively affect setback of starch pastes by influencing pasting and retrogradation properties to a variable extent (Karim et al., 2007).

Physical characteristics

Starch granules consisted of different shapes. Generally, most of the varieties exhibited spherical

Table 1: Root dry matter and starch content of eleven sweetpotato varieties.

Variety	Tuber Dry matter (%)[k]	Total starch (%)[m]	Extractable starch (%)[m]	Recovery (%)
Lunyangwa	33.03±0.15[c]	69.85±0.31[c]	51.25±0.21[d]	73.38±0.55[d]
Semusa	35.20±0.56[de]	60.14±0.41[b]	53.21±0.15[f]	88.47±0.86[e]
Salera	29.00±0.10[a]	88.37±0.25[d]	50.79±0.16[bc]	57.47±0.65[b]
Zondeni	35.10±0.10[d]	78.43±0.64[e]	57.26±0.36[g]	73.01±0.44[d]
Kenya	36.00±0.40[e]	54.72±0.30[a]	50.00±0.20[e]	91.37±0.76[e]
Mugamba	38.83±0.83[f]	74.86±0.35[f]	52.79±0.50[g]	70.52±0.88[cd]
LU96/274	29.40±0.80[a]	79.93±0.70[c]	52.17±0.61[c]	65.28±0.45[c]
LU96/303	39.07±0.15[f]	67.13±0.42[d]	46.33±0.15[e]	69.00±0.72[c]
LU96/304	31.47±0.61[b]	81.02±0.46[d]	45.00±0.44[b]	55.53±0.68[b]
LU96/334	30.87±0.35[b]	91.12±0.61[e]	41.62±0.31[a]	45.68±0.34[a]
LU96/374	31.37±0.45[b]	95.09±0.93[f]	39.62±0.57[a]	41.67±0.86[a]

Means followed by the same superscript in a column are not significantly different at $P \leq 0.05$
[k] Fresh weight basis
[m] Dry weight basis

shaped granules. However, in other varieties like Lunyangwa, LU96/303 and Kenya, a small proportion of oval shaped granules were observed. There were no obvious differences among varieties except for size. Mean granule size varied from 11.6 for Mugamba to 15.8µm for Salera. In general, granule dimensions ranged from 3 to 36 µm. Lunyangwa showed the widest granule distribution (9-36 µm). These values are also consistent with literature figures which have been reported to fall within the ranges of 2 to 42µm (Woolfe, 1992; Chen et al., 2003a). Granule dimensions, size distribution and shape are characteristic of botanical source. One study has shown that growth temperature elevation decreases granule size (Tester and Karkalas, 2001). However, this phenomenon could not apply in the present study because all varieties were subjected to the same treatments, and were hence equally affected by any variation in environmental conditions.

Starch granule size contributes to the rate at which starch gelatinizes and its gelatinization temperature. There is less molecular bonding in larger granules and this leads to faster swelling. It is also speculated that larger granules tend to give higher viscosities than smaller granule fractions. This is because the physical size of the granule makes it more sensitive to shear (Chen et al., 2003b).

Pasting properties of starch extracted from sweetpotatoes

Pasting properties are among the important functional characteristics of starch. When an aqueous suspension of starch is heated above a critical temperature, granules swell irreversibly and amylose leaches out into the aqueous phase, resulting into increased viscosity (pasting) (Brabet et al., 1998).

This leads into the granules being highly susceptible to thermal and mechanical breakdown

Peak viscosity is the point at which gelatinized starch reaches its maximum viscosity during heating in water. It indicates the water binding capacity of a starch (Shimelis et al, 2006). Of interest was the difference in sharpness of the peaks. This varied amongst varieties from a

which consequently leads into a decrease in paste viscosity. On cooling, the starch paste forms a gel coupled with increased viscosity. Pasting and gelation are important properties in determining starch behaviour in various food and industrial applications. They affect starch-based product quality such as texture, stability and digestibility (Brabet et al., 1998).

Pasting properties of the starches from the eleven sweetpotato varieties varied significantly ($p \leq 0.05$) (Table 3). The Rapid Visco Analyser (RVA) viscosity profiles were all of the type A. They were characterised by a high peak viscosity (PV) followed by a major breakdown(Figure1). distinctive sharp peak (LU96/274) to a broad (plateau) peak (LU96/303) (Figure 1).

This difference could be attributed to differences in starch granule sizes within some of the varieties. It has been shown that starches with large granules undergo gelatinization relatively faster than smaller

Table 2   Selected physicochemical characteristics of extracted starch

Variety	Moisture (%)	pH	Phosphorus (mg/g)	Amylose (%)	Granule size (μm)	Size distribution (μm)
Lunyangwa	7.60 ± 0.18^c	4.57 ± 0.06^{ab}	0.76 ± 0.05^b	14.95 ± 2.09^{bc}	12.13 ± 0.32^{ab}	9 - 36
Semusa	12.40 ± 0.11^h	4.43 ± 0.06^a	0.17 ± 0.02^a	18.69 ± 1.96^d	13.63 ± 0.35^{cd}	3 - 18
Salera	7.20 ± 0.06^b	5.57 ± 0.06^c	0.09 ± 0.02^a	10.50 ± 0.55^a	15.80 ± 0.89^e	6 - 24
Zondeni	11.40 ± 0.02^g	5.37 ± 0.12^c	0.03 ± 0.01^a	15.97 ± 0.46^{cd}	12.77 ± 0.25^{bc}	6 - 21
Kenya	11.50 ± 0.08^g	4.87 ± 0.06^b	0.11 ± 0.01^a	11.85 ± 1.26^{ab}	14.43 ± 0.60^d	3 - 21
Mugamba	10.60 ± 0.29^f	5.30 ± 0.36^c	0.13 ± 0.03^a	18.63 ± 2.96^d	11.57 ± 0.83^a	3 - 18
LU96/274	8.00 ± 0.09^d	5.50 ± 0.30^c	0.16 ± 0.02^a	14.96 ± 2.32^{bc}	4.47 ± 0.70^d	4 - 20
LU96/303	8.20 ± 0.06^d	4.57 ± 0.15^{ab}	0.13 ± 0.06^a	12.67 ± 1.73^{ab}	11.70 ± 0.82^{ab}	3 - 15
LU96/304	7.90 ± 0.14^{cd}	5.57 ± 0.15^c	0.11 ± 0.02^a	11.92 ± 0.75^{ab}	15.77 ± 0.59^e	6 - 24
LU96/334	8.60 ± 0.23^e	4.57 ± 0.21^{ab}	0.08 ± 0.01^a	13.78 ± 1.47^{abc}	13.78 ± 0.21^{cd}	5 - 20
LU96/374	6.83 ± 0.33^a	4.33 ± 0.23^a 0.	14 ± 0.06^a	12.03 ± 1.77^{ab}	11.83 ± 0.70^{ab}	6 - 25

Means followed by the same superscript in a column are not significantly different at p≤0.05

Table 3 : Pasting properties of native starch extracted from eleven sweetpotato varieties

Variety	P_{time}^w(Min)	P_{temp}^w(°C)	$PV^w(cP)^x$	$HPV^w(cP)^x$	$Breakdown^w(cP)^x$	$CPV^w(cP)^x$	Stability ratio	Setback ratio
Lunyangwa	5.17 ± 0.01^c	73.63 ± 0.32^a	2179.67 ± 9.04^d	1631.33 ± 28.59^{de}	548.33 ± 19.55^f	2461.67 ± 10.69^b	0.75 ± 0.01^d	1.51 ± 0.02^a
Semusa	5.02 ± 0.03^b	75.88 ± 0.03^d	2080.33 ± 2.08^b	1572.67 ± 6.50^c	507.67 ± 5.13^e	2444.67 ± 4.51^b	0.75 ± 0.01^d	1.56 ± 0.01^{bc}
Salera	5.03 ± 0.03^b	74.29 ± 0.09^b	2179.00 ± 2.00^d	1692.00 ± 3.06^{gh}	486.33 ± 4.62^e	2664.00 ± 2.00^{de}	0.78 ± 0.00^e	1.57 ± 0.00^{cd}
Zondeni	4.98 ± 0.03^b	73.50 ± 0.56^a	2115.00 ± 8.79^c	1541.33 ± 8.04^b	573.67 ± 7.77^g	2639.67 ± 9.65^d	0.73 ± 0.00^c	1.71 ± 0.04^g
Kenya	5.16 ± 0.04^c	73.40 ± 0.06^a	1947.00 ± 9.00^a	1624.33 ± 5.86^d	322.60 ± 14.64^b	2690.33 ± 7.09^{ef}	0.83 ± 0.01^f	1.65 ± 0.01^f
Mugamba	5.40 ± 0.14^d	75.10 ± 0.30^c	1950.00 ± 9.00^a	1728.33 ± 9.93^i	221.74 ± 4.04^a	2646.33 ± 42.92^{de}	0.89 ± 0.01^h	1.53 ± 0.02^{ab}
LU96/274	4.14 ± 0.06^a	73.57 ± 0.08^a	2596.67 ± 7.05^g	1707.33 ± 16.04^{hi}	889.34 ± 9.02^j	2762.00 ± 22.00^g	0.66 ± 0.01^a	1.62 ± 0.03^{ef}
LU96/303	4.14 ± 0.09^a	74.90 ± 0.20^c	2370.00 ± 8.94^e	1672.67 ± 9.45^{fg}	697.30 ± 13.32^i	2585.00 ± 25.00^c	0.71 ± 0.01^b	1.54 ± 0.03^{ab}
LU96/304	5.04 ± 0.04^d	74.20 ± 0.40^b	2404.00 ± 26.23^f	2049.33 ± 29.28^j	354.75 ± 8.08^c	3261.67 ± 23.25^h	0.85 ± 0.00^g	1.59 ± 0.02^{de}
LU96/334	4.12 ± 0.03^a	75.07 ± 0.18^c	2130.67 ± 34.02^c	1496.33 ± 6.51^a	637.33 ± 28.11^h	2304.00 ± 22.27^a	0.70 ± 0.01^b	1.54 ± 0.01^{ab}
LU96/374	5.04 ± 0.04^b	74.17 ± 0.15^b	2111.67 ± 10.41^c	1654.64 ± 13.32^{ef}	457.00 ± 7.00^d	2734.00 ± 14.00^{fg}	0.78 ± 0.01^e	1.65 ± 0.01^f

Means followed by the same superscript in a column are not significantly different at p≤0.05
[w]Starch pasting properties: P_{time} = Time to reach peak; P_{temp} = Pasting temperature; PV = Peak viscosity; HPV = Hot paste viscosity; CPV = Cold paste viscosity
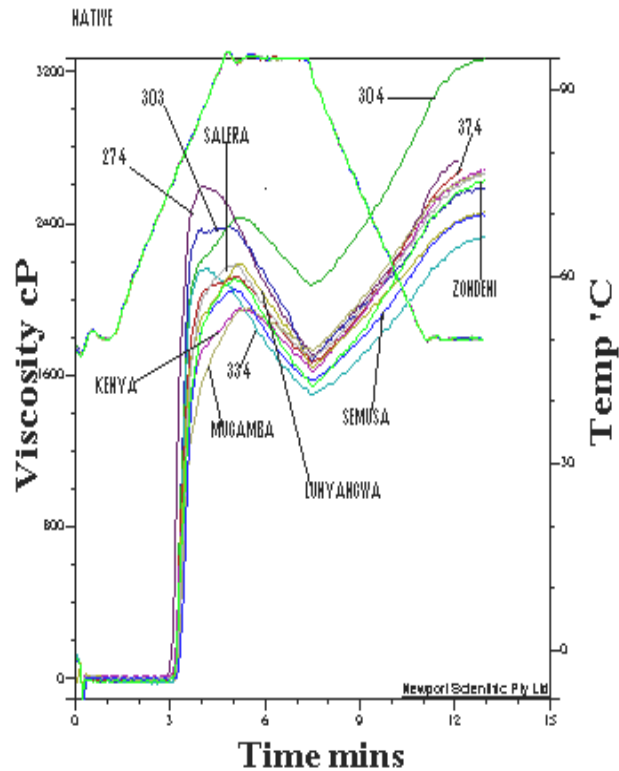[x]Centipoise

Figure 1. RVA viscosity profiles of native sweetpotato starch pastes

fractions because of the less molecular bonding (Chen et al., 2003b). This aids in starches achieving sharper peaks as the swelling is almost uniform and spontaneous than in smaller granule fractions.   However, this study did not show a relationship between mean starch granule size and time required to reach peak viscosity.

LU96/274 recorded the highest PV of 2596 cP, while Kenya had the lowest (1947cp).   Peak viscosity has previously been related to amylose and phosphorus contents. Starch granules with low amylose and high phosphorus have been reported to swell much more freely because starch swelling is mainly a property of amylopectin.   In addition phosphorus is associated with amylopectin to which it is bound in form of phosphate esters (Kim et al., 1996).

LU96/274 showed the highest breakdown (889.33cP) while Mugamba had the lowest (221.67cP). Breakdown is regarded as a measure of the degree of disintegration of granules or paste stability. At breakdown, swollen granules disrupt further and amylose molecules generally leach into solution (Zaidul et al., 2007). It is a measure of cooked starch to withstand shear-induced disintegration.

A significant positive correlation was observed between PV and breakdown (r=0.91, p≤0.01). This entailed that starches which exhibit high PV are likely to have high breakdown values, leading to weak gels. Such gels are most likely to disintegrate under shear and heat (Singh et al., 2006).   This significant relationship could be used to predict the resistance of a particular starch to disintegration upon being subjected to heat and shear (Figure 2).

This finding was supported by a highly significant negative correlation between breakdown and stability ratio (r=-0.97, p≤0.01)(Figure 3). This is an indication that starches with high breakdown are likely to produce unstable pastes (Singh et al., 2006).

Hot paste viscosity (HPV) is the viscosity at the end of holding time at 95°C (Harmdok and Noomhorm, 2006). HPV for the eleven sweetpotato starches ranged from 1496 (LU96/334) to 2049 cP (LU96/304).   The wide variation in HPV could be attributed to a number of factors, one of which is difference in the extent of amylose leaching. Starches whose amylose portion leaches out into the aqueous phase more quickly, have been shown to readily undergo reassociation leading to higher hot paste viscosities (Singh et al., 2006).
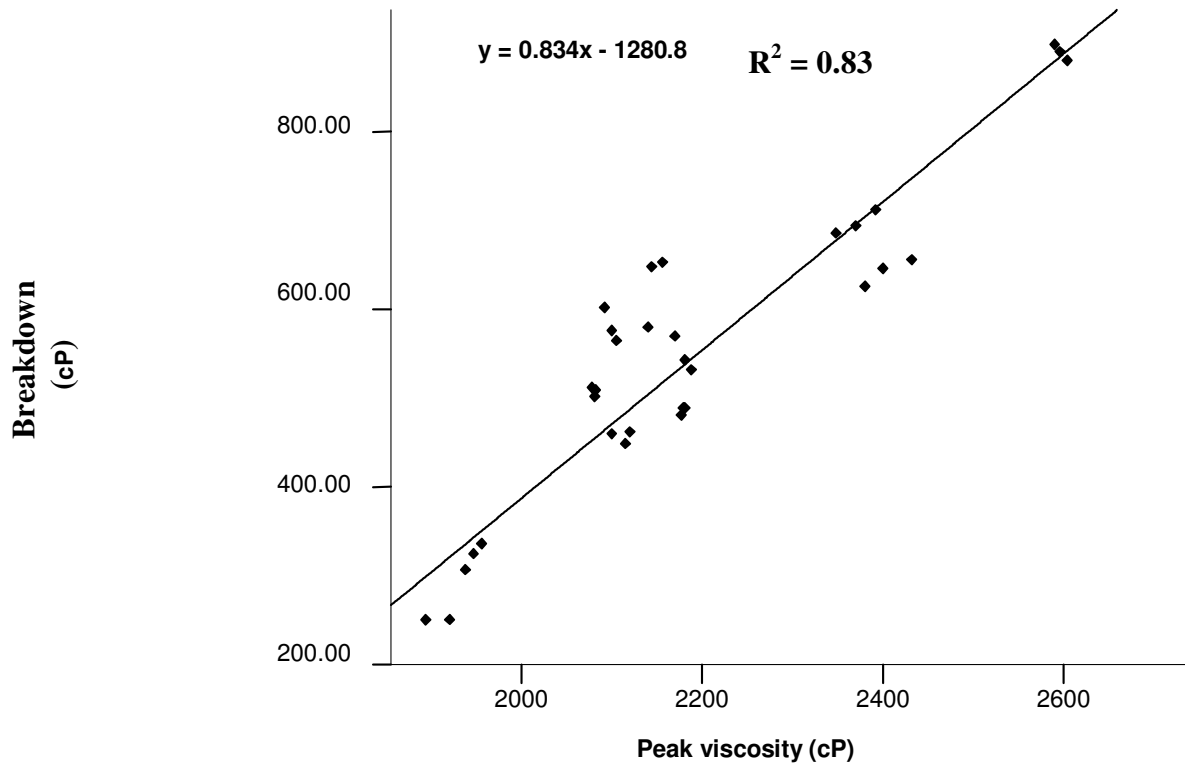
Figure 2   Relationship between peak viscosity and breakdown of sweetpotato starches.

Final viscosity formed at the end of cooling at 50°C is called cold paste viscosity (CPV). This viscosity is used to define a particular quality of starch. It also indicates the stability of cooked starch paste in actual use. In addition, it indicates the ability of a starch to form a paste or gel after cooling (Shimelis et al., 2006). CPV for all the starches were higher than their corresponding PV and HPV, ranging from 2304 (LU96/334) to 3261cP (LU96/304).   The increase in CPV of all the starch varieties could be attributed to aggregation of the amylose molecules on cooling (Kaur et al., 2007). On the other hand, differences amongst varieties in CPV could be associated with differences in amylose contents. High amylose starches have been found to re-associate more readily than high amylopectin starches. This is because the linear chains can orient parallel to each other, moving close enough together to bond (Shimelis et al., 2006). However, in this study, the relationship between CPV and amylose content was non-significant.

Stability ratio of the starch pastes ranged from 0.66 to 0.89. Paste stability ratio is defined as the ratio of viscosity at the onset of cooling to the peak viscosity before cooling (Kim et al., 1996).   It explains the resistance of a starch paste to

viscosity breakdown as shear is applied. Stability ratio was highly and positively correlated to the time required to reach peak viscosity (r=0.83, p≤0.01). Starches with short peak-paste time have been found to have low resistance to swelling. In that case, they would be expected to swell rapidly and become susceptible to concurrent shear-induced disintegration. A long paste-peak time may be associated with granules which swell more gradually and thus are not as susceptible to mechanical damage (Wiesenborn et al., 1994). Time required to reach peak viscosity may, therefore, be used to predict the stability ratio and consequently, the resistance of a starch paste to breakdown.

CONCLUSION

Results of this research revealed significant differences in the physiochemical properties of eleven sweetpotato starches, except for phosphorus content. Dry matter content in sweetpotato tubers can be used for primary screening of sweetpotato varieties for starch production. However, lack of relationship between starch content and yield revealed that starch
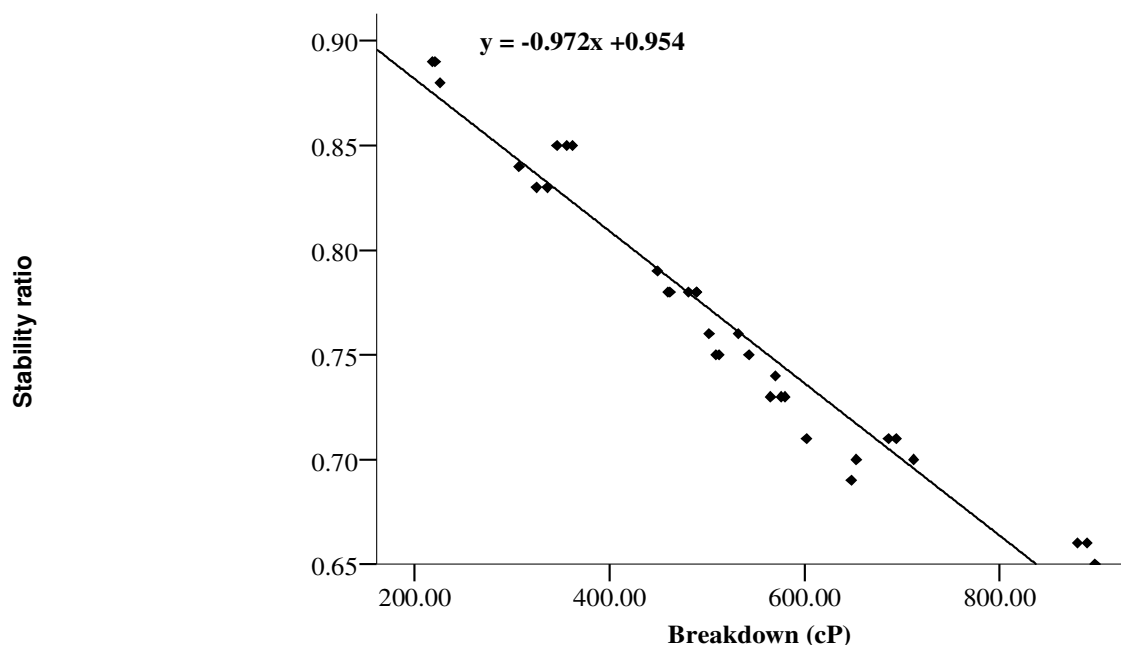
Figure 3. Relationship between breakdown and stability ratio of   sweetpotato starch pastes

extractability is a more important criterion for the choice of variety for starch production. On that basis, Lunyangwa, Semusa, Kenya, Zondeni and Mugamba could be considered as among the best varieties for starch processing.   This is because these varieties showed an extraction rate of over 70% which is considered good enough for industrial processing.

All the eleven starches under investigation exhibited a type A pasting profile. However, there were significant differences in the actual pasting parameters (P_{time}, P_{temp}, PV, HPV, CPV, BD, stability and setback ratios). Significant positive correlation between PV and BD and a negative correlation between BD and stability ratio were observed. This suggested that starches with high PV breakdown easily, leading to weak gels. Such starches (like LU96/274, LU96/303 and LU96/304) could be applied in food industry, especially where low thickening power is required such as in pastries.   Starches with longer paste-peak time were found to be more susceptible to shear-induced disintegration.

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