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NUTRIENT COMPOSITION, AMYLOSE CONTENT AND PASTI CHARACTERISTICS OF SOME ELITE ACCESSIONS OF NERICA RICE

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ABSTRACT

Eighteen elite lines of Nerica rice were assessed for proximate, amino acid composition, amylose content and pasting viscosity. The aim was to nominate the lines for further multilocational yield trails and eventual release as varieties. The lines were parboiled by soaking in hot water (75oC) for 9-20hrs and then steamed for 40-45minutes at75oC in a steamer. Raw and parboiled samples were dehusked and polished and used in subsequent evaluations. The results indicated that protein varied from7.47+0.21to 11.73+0.15% parboiled samples and from 6.87+ 1.01to 11.65+ 0.51% for the unparboiled or raw samples. Fat also varied from 5.57+ 4.22- 6.00+ 0.54 the parboiled samples and from 5.33 to 6.33+ 0.5% for the unparboiled samples. The amino acid profile showed that both parboiled and unparboiled samples met the Food and Agricultural Organization (FAO) requirements for infants, adolescent and adults for histidine, threonine, valine and isoleucine and leucine. Both samples and the check were however deficient in lysine (4.01-4.60). Parboiling did not significantly (p<0.5) improve the proximate and amino acids composition of samples. The unparboiled milled samples had higher amylose content (23.84 – 50.85%) compared to(12.85 – 31.81%) of the parboiled samples. The amylose content of the parboiled samples placed them in the intermediate amylose category. The pasting properties showed that raw samples exhibited conventional non-waxy cereal pasting characteristics while the parboiled samples indicated destructuring in the pasting profile. The results were indicative that the NERICA LINES would have high cooking qualities.

Keywords: Nerica, Lines, Nutrient composition, Amino acids, Amylose composition, Pasting profile Elite Accessions.

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Contribution/ Originality

This paper discusses the nutrient composition of NERICA accessions been bred for eventual release as varieties. This work show that the NERICA lines are not superior in both chemical and nutritional composition to released local varieties. However they will exhibit better cooking qualities.

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1. INTRODUCTION

Rice is the most important cereal for humans; the staple food of over three (3) billion people. According to Brar and Khush (2002) rice accounts for 23% of the world's supply of calories while it remained

an economic crop which is important in household food security, ceremonies, nutritional diversification, income generation and employment (Abulude, 2004). It is utilized mostly at the household level, were it is consumed as boiled or fried or ground rice with stew or soup. Rice is cooked by washing and boiling in water which leads to loss of some nutrient (Perez *et al*., 1987).

"Nerica" simply means new rice for Africa (Seepage *et al*., 2006). The African Rice Center (WARDA) developed several underspecified rice varieties of NERICA by crossing the high yielding Asian rice (Oryza sativa susp Japonica) with the locally adapted African rice (Oryza glaberima). The varieties were named with the prefix NERICA (Smeary *et al*., 2006). It is reported that NERICA has great potentials to benefit African farmers especially Nigeria because of its high yielding ability under topical upland condition in this region since rice is grown in all the ecological and dietary zones of Nigeria with different adaptation traits for each ecology (Sanni *et al*., 2005).

Despite the fact that different varieties of rice are widely cultivated in Nigerian, there is an upsurge in the influence of foreign imported rice varieties into the country. Popular foreign and parboiled rice varieties produced in Thailand widely consumed and imported into Nigeria include"Aroso" rice (Abulude, 2004). Others include the golden rice (genetically engineered to contain beta carotene not present in the standard rice) to combat the wide spread vitamin A deficiency and thus good for eradicating shininess in children of the developing world (Beyer *et al*., 2002; Central and Reeves, 2002).

The Nerica rice has shown to be of high yield and diseases resistant (especially of smut, rust etc) which is a solution to the problems of rice production in sub-Saharan Africa. However their nutritional composition is not yet evaluated. This study reports the proximate, amino acid profile and amylose content of 18 elite lines for advancement to multi-locational yield trails and eventual release as varieties by the National Cereals Research Institute Bida, Niger State Nigeria that have the National mandate for rice genetic improvement in Nigeria.

2. MATERIALS AND METHODS

The (Nerica lines) were collected from the seed store of the National Cereal Research Institute Badegi, Bida Niger State. The Laboratory experiment was conducted at the National Cereals Research Institute Badeggi, Bida Niger State Nigeria and university of Jos, Plateau State Nigeria.

2.1. Preparation of Samples

This was carried out according to the methods of Pilaiyar and Mechandoss (1981). Rice samples (200g) were weighed using an electronic weighing balance. The weighed samples were tied in sacks and soaked in warm water (75^{o}C) for 9 – 20 hours. The samples were parboiled using a steamer with temperatures fixed at 75°C for 40-45 minutes. The samples were later tempered at room temperature for 2 – 3 hours and allowed to cool. The samples were sun dried for 3-5hours at 30-34°C to reduce the moisture level to about 14%.

2.2. Dehusking and Polishing

Raw and parboiled samples were dehusked according to the method of Juliano (1980). The rough rice was hulled / peeled or milled by a McGill Sheller rice mill,(made in Japan).The husk was separated from the grain. The resulting brown rice was polished for 60 seconds in a Satake grain testing mill TMDs (Japan). The rice samples were winnowed in order to remove the chaff after which the samples were ground using Thomas Wicey mill MEDS hammer mill (Japan).

3. ANALYSIS

3.1. Proximate Composition and Amino Acid Analysis

Moisture content, protein, ash, fat, crude fibre and carbohydrate were determined according to procedures reported by Ibitoye (2005). The samples with the highest protein content were selected and used for amino acid profile and pasting characteristics.

3.2. Determination of Amino Acid Profile

Amino acid profile of rice samples was determined as described by Spackman *et al.* (1958).

Pasting Viscosity: The pasting characteristics of raw and parboiled samples were measured using the Rapid 20-Mins RVA test as described in Anounye *et al.* (2007).Samples (3g) were mixed with 25ml of distilled water. A disposable plastic stirring paddle was placed in the cup and rotated by hand for 15-30 seconds, to wet the samples. The sample cup and paddle were inserted into the RVA (New Port Scientific 910140, Sydney, Australia) such that the paddle was held firmly in the drive motor clutch. When the test cycle was activated the split copper block automatically clamp around the can. Total sample size was held constant at 28g. Sample temperature was equilibrated at 50°C for 2mins, then put on the heating cycle for 10mins with a maximum temperature of 95°C and then put on the cooling cycle for 8mins with a minimum temperature of 50°C. The viscosity profiles were recorded on the portable Personal computer (PC) attached to the instrument. All sample analysis was performed twice.

3.3. Apparent Amylose Composition

Apparent amylose content was evaluated according to the procedure described by Perez and Juliano (1978).

4. RESULTS

Table-1. Proximate composition of Nerica lines (parboiled) compared to checks

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fibre(%)	Carbohydrate (%)
L1	8.19±0.03^{c}	8.72±0.28^{d}	5.26±0.41^{c}	0.85±0.30^{b}	1.05±0.67^{c}	76.11±0.29^{a}
L2	8.43±0.15^{c}	10.31±0.29^{b}	6.00±0.24^{b}	1.53±0.58^{a}	2.22±0.78^{b}	72.87±0.55^{b}
L3	9.95±0.13^{a}	7.90 ±0.78^{d}	7.00±0.86^{a}	1.27±0.25^{a}	1.70±0.38^{b}	77.46±0.48^{a}
L4	9.75±0.18^{a}	8.16±0.65^{d}	7.00±0.32^{a}	1.02±0.29^{a}	1.72±0.01^{b}	75.91±0.58^{b}
L5	9.37±0.58^{b}	6.87±1.10^{e}	5.01±0.23^{c}	1.37±0.32^{a}	3.17±1.46^{a}	77.28±1.50^{a}
L6	9.86±0.23^{a}	8.44±0.32^{d}	7.00±0.84^{a}	0.53±0.58^{b}	1.69±0.61^{b}	75.27±0.21^{b}
L7	9.69±0.06^{a}	8.46±0.50^{d}	6.00±0.10^{b}	1.01±0.02^{a}	1.70±0.20^{b}	75.24±0.18^{b}
L8	9.35±0.01^{b}	7.37±0.02^{e}	7.00±0.25^{a}	0.70±0.27^{b}	1.15±0.47^{c}	77.23±0.61^{a}
L9	8.87±0.25^{b}	8.06±0.01^{d}	5.40±0.84^{c}	0.83±0.29^{b}	1.68±0.01^{b}	76.69±0.15^{a}
L10	9.66±0.10^{a}	8.27±0.39^{d}	5.07±4.22^{c}	1.02±0.35^{a}	1.12±0.80^{c}	75.32±0.84^{b}
L11	10.12±0.16^{a}	10.71±0.13^{b}	5.40±0.35^{c}	1.53±0.06^{a}	1.61±0.10^{b}	71.30±0.44^{e}
L12	9.35±0.08^{b}	8.18±0.22^{d}	6.57±0.11^{b}	1.33±0.29^{a}	1.12±0.70^{c}	74.74±0.53^{c}
L13	8.39±0.05^{b}	8.05±0.01^{d}	6.00±0.29^{b}	1.30±0.25^{a}	0.86±0.29^{d}	77.43±0.61^{a}
L14	9.00±0.15^{b}	10.00±0.30^{b}	6.02±0.20^{b}	1.01±0.17^{a}	1.06±0.01^{c}	74.02±0.30^{c}
L15	8.97±0.64^{b}	10.84±0.30^{b}	6.00±0.53^{b}	1.57±0.12^{a}	1.23±0.95^{c}	72.93±0.58^{d}
L16	9.34±0.32^{b}	11.28±0.53^{a}	7.73±0.21^{a}	1.57±0.12^{a}	1.80±1.47^{b}	71.10±0.26^{e}
L17	8.98±0.31^{b}	11.61±0.51^{a}	5.67±0. 84^{c}	1.01±0.02^{a}	2.08±0.07^{b}	72.90±0.48^{d}
FARO 46	8.25±1.47^{b}	10.84±0.30^{b}	6.00±0.23^{b}	1.57±0.12^{a}	1.56±0.42^{b}	72.04±1.18^{d}
FARO 48	8.90±1.30^{b}	11.00±0.18^{a}	6.00±0.29^{b}	1.37±0.32^{a}	1.07±0.02^{c}	72.47±0.27^{d}

L1-L18: NERICA Lines. FARO46 and 48 are already released rice varieties in Nigeria
Values are means and standard deviation of three determinations.
Values with the same superscript in the same column are not significantly (P>0.05) different

Table-2. Proximate compositions of Nerica lines (unparboiled) compared to released checks

SAMPLE	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fibre(%)	Carbohydrate (%)
N1	10.00±0.10^{a}	8.43±0.15^{d}	6.60±0.53^{a}	0.68±0.44^{c}	0.21±0.10$^{a, b}$	68.63±0.35^{c}
N2	10.00±0.10^{a}	11.33±0.15^{a}	5.50±0.46^{b}	0.19±0.01^{c}	0.18±0.01^{a}	67.77±0.25^{e}
N3	10.00±0.10^{a}	8.17±0.15^{d}	5.00±0.06^{b}	1.13±0.01^{b}	0.26±0.01^{c}	70.90±0.36^{b}
N4	10.00±0.10^{a}	6.53±0.15^{f}	5.00±0.58^{b}	0.16±0.01^{c}	0.26±0.01^{a}	72.97±0.96^{a}
N6	10.01±0.01^{a}	11.03±0.15^{a}	6.93±0.51^{a}	0.21±0.01^{c}	0.26±0.02^{a}	64.77±0.65^{g}
N7	9.40±0.10^{b}	8.17±0.15^{d}	6.33±0.58^{a}	0.53±0.40^{b}	0.20±0.01^{a}	68.43±0.35^{d}
N8	10.00±0.10^{a}	10.07±0.15^{b}	5.53±0.58^{b}	0.13±0.01^{c}	0.51±0.01^{e}	68.90±0.27^{c}
N9	10.00±0.10^{a}	8.13±0.15^{d}	5.68±0.55^{b}	0.20±0.01^{c}	0.23±0.56^{a}	71.23±0.78^{b}
N10	9.00±0.10^{b}	10.03±0.15^{b}	5.93±0.12^{b}	0.16±0.01^{c}	0.70±0.01^{a}	68.70±0.27^{c}
N11	9.00±1.53^{b}	8.17±0.15^{d}	6.50±0.10^{a}	0.79±0.51^{b}	0.40±0.10^{a}	68.07±0.3^{d}
N12	9.00±0.10^{a}	11.63±0.15^{a}	6.50±0.12^{a}	0.25±0.10^{c}	0.61±0.10^{a}	66.27±0.32^{f}
N13	9.17±0.15^{b}	8.00±0.10^{d}	5.00±0.12^{b}	0.26±0.10^{c}	0.21±0.10^{a}	72.87±0.32^{a}
N14	9.00±0.15^{b}	7.47±0.21^{e}	5.53±0.06^{b}	0.21±0.10^{c}	0.55±0.10^{a}	71.93±0.38^{b}

N15	10.30±0.10^{a}	8.43±0.15^{d}	3.50±0.50^{a}	0.18±0.01^{c}	0.54±0.04^{a}	73.63±0.76^{a}
N16	9.33±0.15^{b}	8.37±0.21^{d}	6.33±0.58^{a}	0.17±0.01^{c}	0.61±0.10^{a}	69.30±0.79^{c}
N17	10.10±0.10^{a}	10.00±0.15 b	5.87±0.55^{b}	0.22±0.01^{c}	0.55±0.10^{a}	68.83±0.78^{c}
N18	10.00±0.10^{a}	8.47±0.15^{d}	5.33+0.58^{b}	3.55±0.01^{a}	0.25±0.10^{a}	69.03±0.95^{c}
FARO 46	10.20±0.10^{a}	10.00±0.15 b	5.34±0.58^{b}	3.93±0.01^{a}	0.59±0.01^{a}	68.30±0.82^{d}
FARO 48	10.00±0.10^{a}	9.03±1.36^{c}	5.87±0.55^{b}	3.62±0.93^{a}	0.55±0.10^{a}	66.63±0.90^{f}

Values are means and standard deviation of three determinations

Values with the same superscript in the same column are not significantly (P>0.05) different

Table-3. Amino acid Composition of Unparboiled, and Parboiled Nerica lines compared to Check (FARO 46).

Amino Acid	Un-parboiled	Parboiled	FARO 46 (parboiled)
Lysine	4.01±0.01^{a}	4.26±0.36^{a}	4.06±0.05^{a}
Histidine	2.50±0.01^{a}	2.46±0.07^{a}	2.39±0.44 ^{a}
Argine	6.39±0.01^{a}	6.56±0.36^{a}	5.11±0.15^{b}
Aspartic Acid	6.65±0.01^{b}	7.84±0.50^{a}	6.80±0.42 ^{b}
Threonine	3.57±0.01^{a}	3.75±0.35^{a}	2.96±0.07 ^{a}
Serine	2.80±0.01^{b}	3.04±0.02^{a}	3.90±0.14 ^{a}
Glutamic acid	8.25±0.01^{c}	8.77±0.96^{b}	11.5±0.74 ^{a}
Proline	2.71±0.01^{a}	3.19±0.45^{a}	2.52±0.68 ^{a}
Glysine	4.83±0.01^{b}	5.25±0.34^{a}	3.05±0.64 ^{b}
Alanine	4.29±0.01^{a}	4.58±0.02^{a}	3.23±0.89 ^{b}
Cystine	1.03±0.01^{a}	1.16±0.23^{a}	1.20±0.03 ^{a}
Valine	5.61±0.01^{a}	5.16±0.06^{a}	4.26±0.62 ^{b}
Metheonine	1.85±0.01^{a}	1.67±0.59^{a}	2.47±0.62 ^{a}
Isoleucine	3.69±0.01^{a}	3.83±0.29^{a}	3.50±0.70 ^{a}
Leucine	7.88±0.01^{a}	8.38±0.19^{a}	5.11±0.14 ^{c}
Tyrosine	4.30±0.01^{a}	3.38±0.42^{a}	3.94±0.30 ^{a}
Phenylalanine	5.12±0.01^{a}	5.46±0.66^{a}	4.20±0.28 ^{a}

Values are means and standard deviation of three determinations

Values with the same superscript in the same rows are not significantly (P>0.05) different

Table-4. Apparent Amylose Content of Nerica Lines

Sample Lines	Unparboiled	Parboiled
N1	39.18 ± 0.17[c]	12.85 ± 0.00[l]
N2	50.85 ± 0.30[a]	29.02 ± 0.17[b]
N3	32.85 ± 0.29[e]	14.18 ± 0.17[k]
N4	27.85 ± 0.29[f]	12.52 ± 0 .44[l]
N5	24.85 ± 0.00[h]	15.85 ± 0.29[j]
N6	28.02 ± 0.44[f]	13.85 ± 0.00[k]
N7	55.52 ± 0.167[a]	12.02 ± 0.17[l]
N8	41.25 ± 0.30[b]	17.02 ± 0.44[i]
N9	23.85 ± 0.00[i]	19.02 ± 0.17[h]
N10	50.35 ± 0.30[a]	31.18 ± 0.33[a]
N11	34.35 ± 0.00[d]	22.85 ± 0.00[e]
N12	38.52 ±0.17[c]	26.85 ± 0.29[c]
N13	28.35 ± 0.30[f]	19.35 ± 0.00[h]
N14	34.01 ± 0.16[d]	18.85 ± 0.00[h]
N15	32.35 ±0.29[e]	25.85 ± 0.29[d]
N16	24.18 ± 0. 57[h]	20.18 ± 0.17[g]
N17	24.68 ± 0.76[h]	19.02 ± 0.17[g]
FARO 46	34.85 ± 0.00[d]	26.52 ± 0.17[c]
FARO 48	26.85 ± 0.29[g]	21.52 ± 0.17[f]

Values are means of three determinations

Values not followed by the same superscript are significantly (P≤ 0.05) different along column.

Table-5. Pasting Characteristics of Raw and Parboiled Nerica Line

Sample	PARAMETERS						
	PV (RVU)	TR (RVU)	B D (RVU)	F V (RVU)	SB (RVU)	P T (min)	PTEMP (^{o}C)
N17U	151.05±2.38[a]	75.55±1.88[b]	75.50±0.50[a]	230.29±3.40[b]	-154.75±1.67[b]	5.50±0.03[b]	62.40±0.50[a]
N17P	81.91±0.67[c]	60.54±0.46[c]	21.38±0.21[c]	143.21±1.85[c]	-82.67±1.42[c]	5.07±0.00[b]	61.83± 0.03[a]

KEY:

U= UnparboiledP=parboiled. PV= Peak Viscosity; TR= Trough ; BD= Break Down Viscosity; FV= Final Viscosity; SB Set Back Viscosity ;PT= Peak Time; and Ptemp= Pasting Temperture.

Values are means of three determinations. Means not followed by the same super script along the columns is significantly different at p≥ 0.05

5. DISCUSSION

5.1. Proximate Composition of Nerica Lines

The moisture content of samples ranged from 8.09% to 10.30% for unparboiled (raw rice) and 8.19% - 10.12% for parboiled samples. According to Richard and William (1990) the optimum moisture content for storage lies between 12 and 14%, which may also influence some other quality characteristics such as milling and head rice recovery, cooking quality and storage period (Purseglove, 1992). Dhaliwal *et al.* (1991) reported that moisture content of IR-8 PR-108 and Basmati-370 varied from 14-15.4% and 12.4-13.1% for dried and non dried samples after one month of harvest.

The disclosed that moisture content equilibrated according to temperature and relative humidity regardless of initial moisture levels and concluded that variation of moisture content was significant among varieties.

The findings of this present study confirmed these assertions. The results showed that the accessions would best able moisture- wise during storage. The protein values ranged from 7.74% - 11.63%. Huifeng *et al.* (2010) had noted that clarifying the effect of protein on physicochemical properties of rice will help deepen insights into the biochemical basis of rice quality. According to them protein is a major factor in determining the texture, pasting capacity, and sensory characteristics of milled rice.

Proteins had been reported to play significant roles in determining the functional properties of the starch, including inhibiting the swelling of starch granules, reducing the pasting and crystallizing capacities, and increasing the pasting temperature of the isolated rice starch Shih (2004).

Frederick and Kim (2000) have reported that the protein content in milled rice or regular rice flour is relatively small (7–9%), however, rice proteins have been recognized as highly nutritious, hypoallergenic, and particularly healthful for human consumption. But have reported that rice protein content varied from 4.9 to 19.3% for *indica* and from 5.9 to 16.5% in *japonica germpalsm.* The results obtained were a bit higher than the range of values (5-8%) reported by Danbaba *et al.* (2013) for FARO 46I, NERICA I and 8, but were within the range of values reported. Have explained that rice protein content is a typical quantitative trait easily affected by environmental factors hence the difference in reported values are expected.

The fat content of Nerica lines ranged from 5.20 – 7.73%. These values were significantly ($P \leq 0.05$) higher than the values (0.80%) and (3.30%) reported for white rice flour and brown rice flour respectively by Liang and King (2003) and also the reported values (1.6 – 2.8%), for brown rice by Ihekoronye and Ngoddy (1985).

Higher lipid content gives rice better polishing quality Purseglove (1992). However it poses serious problems for storage of milled rice product.

5.2. Amino Acid Pofile

Amino acid analysis showed that parboiled and unparboiled samples of NERICA had comparable amino acid profile with the released variety (FARO 46). Gropper *et al.* (2005) have listed nine amino acids, including lysine, methionine, threonine, tryptophan, histidine, leucine, isoleucine, valine, and phenylalanine, as essential amino acids in human nutrition while cysteine and tyrosine are non essential amino acids, but are synthesized from methionine and phenylalanine, respectively, and can act as substitutes for some amino acids.

Thus, the amounts of 2 amino acid combinations, namely, methionine + cysteine (TSAA, total sulphur-containing amino acids) and phenylalanine + tyrosine (AAA, aromatic amino acids), are used to determine protein nutritional value (Sung-Wook *et al.*, 2015).

The results from this present study showed that the NERRICA accession had significantly$\leq$(0.05) higher concentrations of lysine, histidine, threonine, leucinevaline, and phenylalnine than the 35 cultivars of Malysian brown rice reported by Shahin *et al.* (2009) for both parboiled and unparboiled samples.

Barbeau and Hilu (1993) and Shahin *et al.* (2009) had reported destruction of cysteine during acid hydrolysis, the present results contrasted with these earlier ones though values reported for cysteine were low as expected.

The results were however closer to the values reported for ofada rice samples (Anounye *et al.*, 2007) though the ofada samples had significantly ($P \leq 0.05$) higher levels of sulphur amino acids than the NERRICA accessions and the check. Compared to the FAO/WHO/UNU (1985) recommendation for amino acids the NERICA lines and check were deficient in lysine but met the recommendation for threonine, isoleucine, leucine and valine.

Rice has been found to be rich in glutamic acid, arginine, leucine, threonine and methionine. Even though lysine content of rice is the highest among the other cereals, it is the limiting amino acid for rice itself, followed by threonine and tryptophan (Sekhar and Reddy, 1982; Sotelo *et al.*, 1994). The findings of this present study agreed with these earlier reports.

5.3. Amylose Content

The results showed that the unparboiled samples had amylose content (≥25%) while the parboiled samples were within the range (20-25%). Parviz *et al.* (2014) and Torit *et al.* (2015) have reported that grain protein and amylose contents are two important quality parameters that greatly affect the physicochemical as well as cooking quality of rice. According to them the proportion of amylose in rice and wheat has a large impact on its use and desirability, and the sensory properties of the grain are partly determined by the amylose content. Increased amylose in food is therefore associated with increased resistant starch hence amylose content must be considered in selection of elite lines for improved grain protein content.

Cruz and Khush (2000) and Parviz *et al.* (2014) have shown that rice varieties are grouped based on their amylose contents into waxy (0 – 2% amylose content), very low (3-9%), intermediate (20-25%) and high (>25%). Juliano (1971) had explained that higher amylose cultivars (>25%) are prevalent in indica rice and correlates with dry, firm and separate grains of cooked rice, usually becoming hard after cooling. Intermediate amylose (20–25%) rice is soft but not sticky and generally favoured by most consumers.

Low amylose cultivars (15–20%) are tender, cohesive, and glossy, found in nearly all temperate japonica cultivars whereas very low and waxy rice grains are sticky. The results of this work indicate that 11 accessions (NI, N2, N3, N7, N8 N10, N11 N12, N14 and N15) corresponding to apparent amylose content in the range of (32-55%) will exhibit high amylose content without proper parboiling operations. Parboiling however will cause accession lines (NI, N3, N4, N6, N7, N13, N14, N16 and N17) to fall within the low amylose category while the rest of the accessions will be of the intermediate category.

Parviz *et al.* (2014) had reported that differences in amylose content could be affected by the climatic and soil conditions during grain development.

5.4. Pasting Characteristics

The results of pasting characteristics of raw and parboiled lines16 and 17 is shown in table (5) There was significant ($p \leq 0.05$) differences in the pasting properties of raw and parboiled samples which was expected.

The results showed that the minimum temperature required for cooking the accession(Line 17) for raw and parboiled samples respectively ranged between 61-62°C respectively which was not significantly different ($P \leq 0.05$). The importance of the peak viscosity PV, the pasting temperature $P_{Temp,}$ the break down BD and the set back SB have been explained by Wani *et al.* (2012); Sang *et al.* (2008).

Xiangli *et al.* (2014) reported peak viscosity values for rice starch from 200-350RVU for diverse cultivars of rice varying in amylose content. For cultivars of intermediate amylose content 282-301 RVU reported were significantly ($P \leq 0.05$) higher than the (151RVU) or the (82RVU) recorded for the unparboiled and parboiled samples respectively. The same also hold for the break down viscosities. But Seung-Taik *et al.* (1999) had reported peak viscosities of 159RVU and Break down(BD) viscosity of 92RVU and Set Back(SB) viscosity of 79RVU.

The results obtained for pasting properties in this current work were closer to the report of Seung-Taik *et al.* (1999).

However the NERICA accessions had significant ($P \leq 0.05$) lower set back viscosity. Asante *et al.* (2013) had reported that high values in BD and low values in SB are indicative of high cooking quality since neither the cooked rice retrogrades nor becomes stiff upon cooling. According to values reported by Xiangli *et al.* (2014) lowest BD for the intermediate category was 186 RVU while the lowest SB was -52RVU.

This result is comparable to 75 RVU and -154RVU recorded for the BD and SB respectively. From these results it could be affirmed that the accession line 17 would have high cooking qualities. The results further showed that the NERRICA lines would cook faster than the varieties reported by Xiangli *et al.* (2014).

6. CONCLUSION

The results of proximate, amylose content and amino acid profile showed that the food values of the accessions are within the ranges of already released varieties.

The results show that parboiling will cause most of the accession to be in the intermediate category of amylose rice while the pasting profile indicate that the accessions may have good cooking qualities.

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