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Chemical composition and oil quality of seeds of sesame accessions grown in the Nsukka plains of South Eastern Nigeria

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Sesame, *Sesamum indicum* L. is one of the oldest and important oil seed crop in the world. The sesame seed apart from providing edible oil is also rich in protein. This study was carried out to evaluate the chemical composition and oil quality of seeds of 13 accessions of sesame grown in the Nsukka plains of South eastern Nigeria. The treatments which comprised of the 13 accessions were laid out in a randomized complete block design (RCBD) experiment in three replications. At maturity, samples of seeds were taken to the laboratory for chemical analysis. The result revealed significant variation in chemical composition and oil quality of the seeds of the sesame accessions. Percentages moisture, protein, fibre, fat, carbohydrate and ash in the seeds ranged from 5.0 to 8.0, 17.08 to 20.90, 1.40 to 2.40, 28.0 to 46.0, 27.63 to 44.85 and 1.10 to 2.90, respectively. The ranges of iodine value, peroxide value, acid value and free fatty acid were 76.14 to 130.07 g/100 g, 1.01 to 7.61 meq (H_2O_2), 0.67 to 2.85 mg/g and 0.34 to 1.43 mg/g, respectively. Highest percentage fat was recorded in the accession Yobe gadaka while Parchequeno had the highest percentage protein among the accessions.

Key word: Sesame, accessions, seed composition, derived savanna.

INTRODUCTION

Sesame (*Sesamum indicum*) is a member of the Pedaliaceae plant family. The sesame is one of the world most important and oldest known oil seed crops (Abou-Gharbia et al., 1997). Its cultivation dated as far as 1500 BC in the Middle East, Asia and Africa (Ali et al., 2007). It took the 9th position among the top 13 oilseed crops which make up 90% of the world production of edible oil (Adeola et al., 2010). The sesame crop is adapted and cultivated both in the tropic and temperate zones of the world (Biabani and Pakniyat, 2008). It is grown mostly for the oil extracted from the seed which is edible and use for industrial and pharmaceutical purposes. The oil is used in the production of perfumes, skin conditioning agents, moisturizers, hair creams, bath oil, insecticides, paints, vanishes and drugs (Mohammed and Hamza, 2008). The seed is also consumed throughout the world in condiments and as an essential constituent in different recipes (Xu et al., 2005; Alyemeni et al., 2011). It is used to add texture and flavor to bread, biscuit, cracks and salad dressing. Sesame seed has been shown to contain about 35 to 60% of oil (El Khier et al., 2008; Alyemeni et al., 2011; Borchani et al., 2010; Jimoh et al., 2011; Mohammed and Hamza, 2008). The sesame oil has also been reported to show remarkable stability to oxidation due to the present of lignins (sesamol, sesamolin and (Lee et al., 2008). These make sesame oil

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Alyemeni et al., 2011). Nigeria is one of the major producers and exporters of sesame seed and ranked 6th among world sesame producing countries and 3rd in Africa (FAO, 2005). The production of sesame in Nigeria is concentrated in the Guinea Savannah zone (Middle Belt). Due to the increasing demand for sesame seed as a result of its enormous uses, there is a need to expand the area of cultivation as a way boosting production. Various researches have been carried in areas outside the traditional producing area in Nigeria to determine the growth and yield potential of sesame types and possibility of a viable commercial sesame production in these areas. Such researches carried out in the Forest-Savanna transition zones of South East and West Nigeria have shown that performances are comparable to what is obtained in the guinea savanna zone (Ogbonna and Umar-Shaba, 2011; Olowe, 2007). The quantity and quality of the oil contained in the seed have been shown to depend on ecological factors such as climate and soil type and on cultivars and maturity of plant (Rahman et al., 2007). This study was therefore carried out to evaluate the chemical composition and oil quality of seeds of 13 accessions of sesame grown in the derived savannah agro-ecology of South Eastern Nigeria.

MATERIALS AND METHODS

This study was conducted in 2009 and repeated in 2010 at the Department of Crop Science Experimental site, University of Nigeria, Nsukka located on latitude 06° 52^{l} North, longitude 07° 24^{l} East and an altitude of 447 m. The materials consisted of 13 sesame accessions. These are; Adaukiari, Chimkwale yellow, 34-4-1, Cameroun white, Parchequeno, E8, Aliade, Kachia, Jigawa, Chimkwale, 69-1-9, Yobe gadaka and NCRI BEN 02M. These are popular accessions grown in the Guinea savannah area which is the major area of production in Nigeria.

The experiment was laid out in randomized complete block design (RCBD) with three blocks. Each block was divided into 13 plots each measuring 3 x 2 m. The 13 sesame accessions were randomly allocated to the plots in each block. The sesame seeds were sown at the spacing of 60 x 30 cm. NPK 20:10:10 fertilizer was applied at the rate of 200 kg/ha a month after planting. At maturity the sesame plants were cut and tied together in bundles in each plot and allowed to dry in the field. The seeds were later extracted and packaged according to the experimental layout.

Chemical analysis of sesame seed

Samples of seeds from each plot were taken to the laboratory for proximate analysis for the determination of moisture, protein, fat, carbohydrate, ash and fibre content in the seeds. The method of proximate analyses was the standard procedure of AOAC (1995). Iodine value, peroxide value, acid value and free fatty acid of the seed oil were also determined.

Moisture content was estimated by drying in an oven at 100 to 105°C to a constant weight. Crude protein determination was by the Kjeldahl method. Crude fat content was determined using the continuous extraction in a Soxhlet apparatus (dimethyl ether was used as solvent). Ash content was determined by incinerating in a furnace at 550°C for 5 h. Crude fibre was determined by segmental hot digestion of the defatted sample with dilute acid and alkaline solutions. Iodine value, peroxide value and acid value were determined according to the AOAC (1995). Free fatty acid (FFA) was obtained from the relation: one unit of acid value = 0.053% FFA (Ajiwe et al., 1997).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) according to the procedure described by Steel and Torrie (1980) for RCBD experiments. Separation of treatment means was carried out using the F-LSD procedure as described by Obi (2002). Test of significance was at 5% probability level.

RESULTS

Table 1 presents the weather record on rainfall, temperature and relative humidity for the years 2009 and 2010 taken from the University of Nigeria meteorological station located at about 200 m away from the experimental site. The record indicated that higher amount of rainfall was recorded in 2009 than 2010. It also showed that rainfall started earlier in 2009. Generally, the differences in these weather factors between the two years were small.

2009 experiment

The result of the proximate analysis carried out on the raw sesame seeds of the 13 accessions showed considerable and significant variability in moisture, crude protein, crude fibre, crude fat, carbohydrate and ash content among the accessions. There was significant difference in moisture percentage among the accessions as shown in Figure 1. Chimkwale had the highest moisture content while 69-1-9 and Yobe gadaka contained the lowest moisture in the seeds. There was insignificant difference between the moisture content in Chimkwale and Adaukiari, 34-4-1, Cameron white, Parchequeno, Aliade and NCRI BEN 02M. The result presented in Figure 2 indicated that Parchequeno had the highest crude protein content.

It however differed significantly only from Cameroun white, Chimkwale, Yobe gadaka and Kachia in protein content. Crude fibre content was highest in Parchequeno while the lowest value was obtained from Aliade. Parchequeno, Adaukiari, Camerooon white, Chimkwale, 34-4-1 and Chimkwale yellow had statistically the same crude fibre content (Figure 3). Crude fat content was highest in Yobe gadaka and differed significantly from the rest of the accession. Accession 69-1-9 had the least fat content (Figure 4). Accession 69-1-9 top the other accession in carbohydrate content. Its value was however statistically the same with what were obtained from E8, Jigawa and Aliade. Yobe gadaka had the least carbohydrate content among the accessions (Figure 5). Ash content was highest in Adaukiari, though the value

Table 1. Weather records on rain days, amount of rainfall, maximum and minimum temperatures and relative humidity in the study area in the years 2009 and 2010.

Months	2009						2010					
	Rain days	Rain fall (mm)	Temp (°C)		Rel. humidity (%)		Rain days	Rain fall (mm)	Temp. (°C)		Rel. humidity (%)	
			Max.	Min.	0900 h	1600 h			Max.	Min.	0900 h	1600 h
Jan	3	53.59	31.90	21.45	71.39	58.63	0	0.00	32.90	20.26	66.63	50.87
Feb	1	2.19	32.46	22.79	74.61	59.43	0	0.00	33.89	23.32	71.68	57.18
Mar	0	0.00	33.61	23.32	72.81	57.03	3	43.88	34.03	23.26	69.97	53.81
April	11	180.6	31.37	21.60	76.20	66.20	7	161.80	32.83	23.07	73.10	63.87
May	10	283.69	30.23	21.42	74.16	70.32	10	212.34	30.39	22.23	73.48	68.81
June	18	152.51	29.13	20.83	74.67	72.67	18	247.39	29.13	21.47	75.90	70.77
July	16	248.17	28.65	20.58	74.84	74.58	17	158.48	27.94	21.00	76.52	71.29
Aug	18	260.33	27.48	20.84	75.00	75.00	18	404.15	27.55	21.16	77.16	72.68
Sept	17	175.76	27.87	20.10	74.67	74.50	18	203.95	28.13	20.73	77.13	71.80
Oct	17	387.10	28.39	20.26	74.94	74.74	18	183.63	28.97	20.84	76.00	68.45
Nov	5	103.18	29.85	19.30	63.80	61.73	2	19.31	30.03	21.23	73.70	64.03
Dec	0	0.00	32.71	18.84	65.35	48.68	0	0.00	32.10	18.32	61.23	48.16

was statistically the same with the values obtained from Chimkwale yellow, Jigawa, Chimkwale and Kachia. Cameroon white had the least ash content (Figure 6).

Result of the analyses done on the quality parameters of the sesame seed oil also indicated significant variation among the accessions. The highest iodine number was recorded from Yobe gadaka while Jigawa had the least value of iodine number. It was also noted that the iodine number recorded from Yobe gadaka was significantly higher than those of other accessions with the exception of Adaukiari (Figure 7). Peroxide value was highest in Adaukiari and Chimkwale and they differed significantly from the other accessions. Yobe gadaka had the least value among the accessions (Figure 8). Figure 9 showed that accession 34-4-1 registered the highest acid value. It was however statistically the same with the acid values obtained from Parchequeno, Chimkwale yellow Kachia and Adaukiari. The least acid value was recorded from 69-1-9. Accession 34-4-1 had the highest free fatty acid in the seed oil and differed significantly from all the accessions with the exception of Parchequeno and Chimkwale yellow. The least free fatty acid was recorded from 69-1-9 (Figure 10).

2010 experiment

The result of the 2010 experiment followed the same trend observed in the 2009 experiment (Table 2). The slight variations between the values obtained from the two years were not significant, more so the accessions still maintained their rankings in the second year in all the attributes studied.

DISCUSSION

The variability in chemical composition and oil quality recorded among the accessions in the presented study agreed with reports of other researchers in sesame. There was however differences in the values between their reports and what were obtained in this study. The range of moisture content of 5 to 8% obtained in this study is higher than 4.16 to 4.62 and 2.7 to 4.7% reported by Tokusoglu et al. (2004) and El Khier et al. (2008), respectively. The mean moisture content of 6.20% was however less than the mean of 8.5% recorded by Jimoh et al. (2011) in other accessions of sesame. It has been shown that high moisture content encourages the growth of micro organisms thereby causing the deterioration of stored seeds (Afolabi, 2008). The high moisture content therefore implies that the seeds may not store well and to avoid this, effort should be made to reduce the moisture content before storage of the seed. The crude protein content in the accessions was low when compared to what were obtained elsewhere. The range of 17.08 to

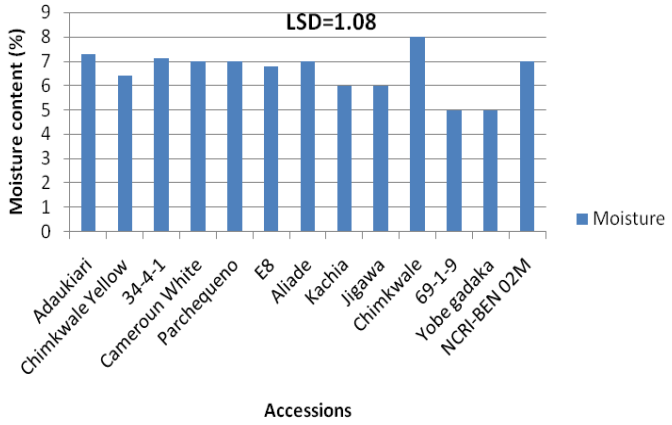

Figure 1. Percentage moisture content in seeds of 13 sesame accessions in 2009 experiment.

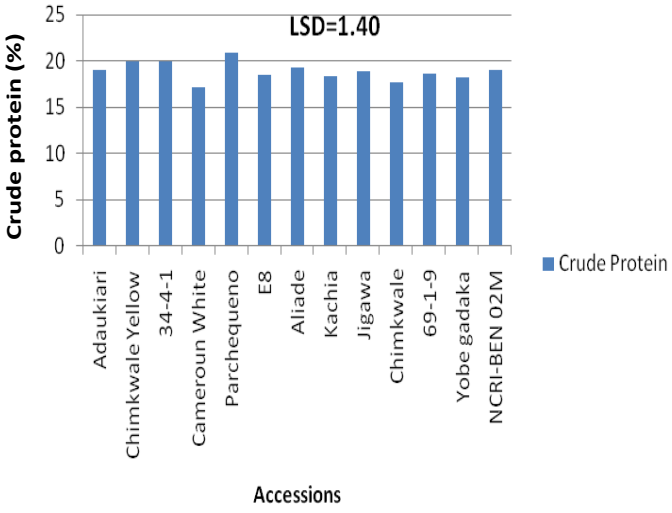

Figure 2. Percentage crude protein content in 13 sesame accessions in 2009 experiment.

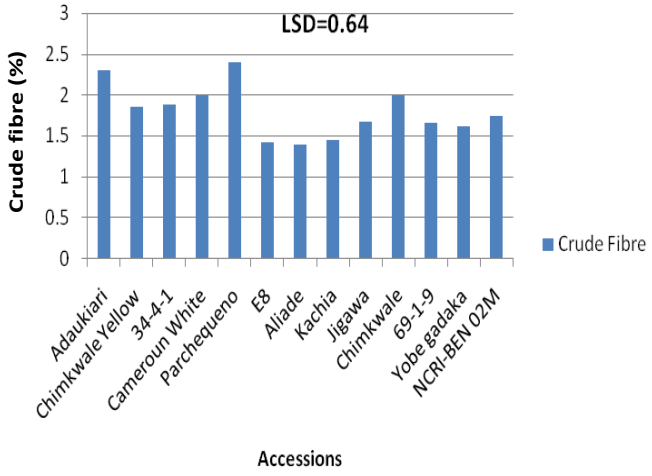

Figure 3. Percentage crude fibre content in the seeds of 13 sesame accessions in 2009 experiment.

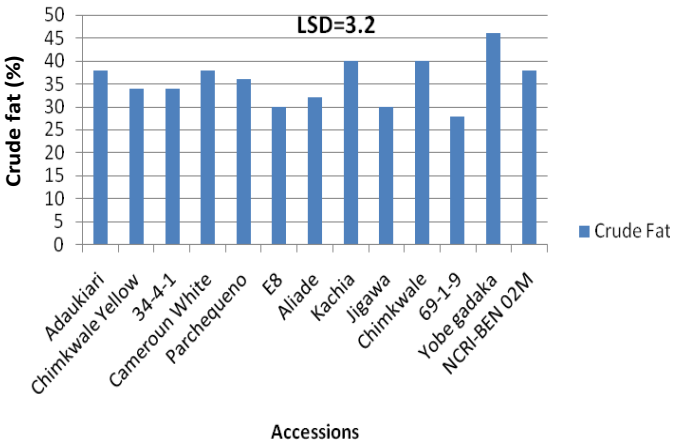

Figure 4. Percentage crude fat content in the seeds of 13 sesame accessions in 2009 experiment.

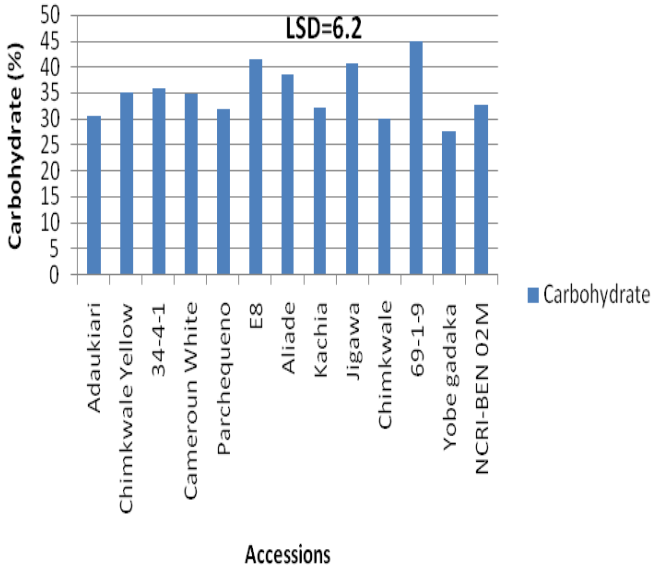

Figure 5. Percentage carbohydrate content in the seeds of 13 sesame accessions in 2009 experiment.

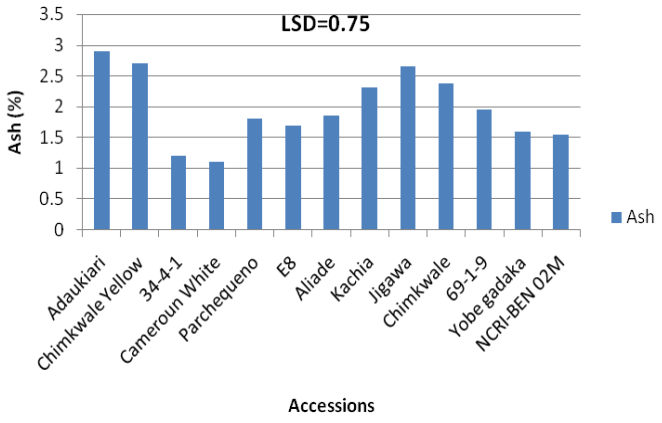

Figure 6. Percentage ash content in the seeds of 13 sesame accessions in 2009 experiment.

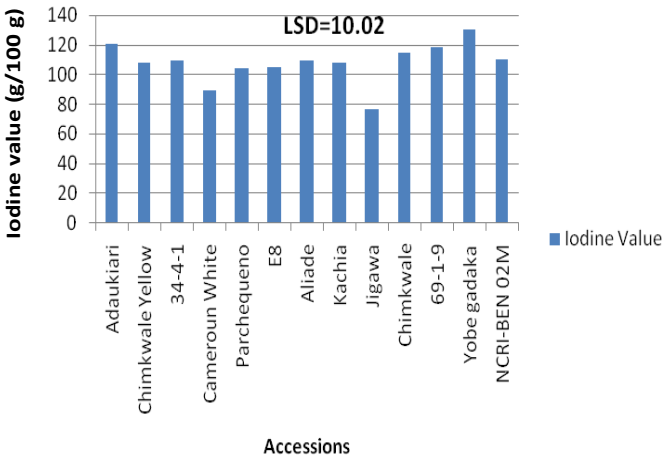

Figure 7. Iodine values of seed oil of 13 sesame accessions in 2009 experiment.

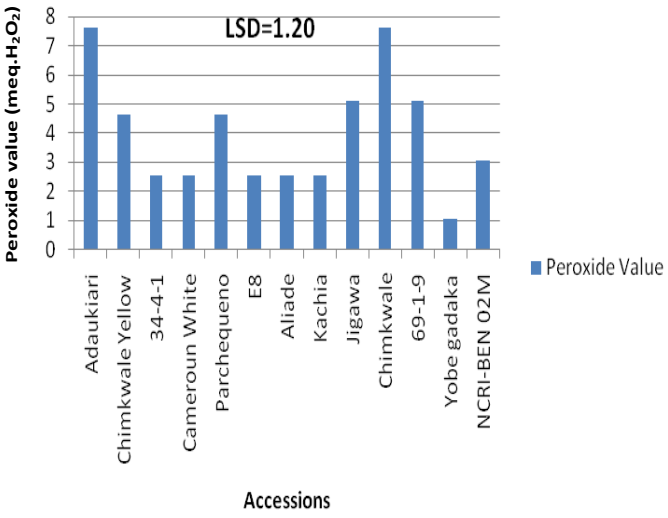

Figure 8. Peroxide value of the seed oil of 13 sesame accessions in 2009 experiment.

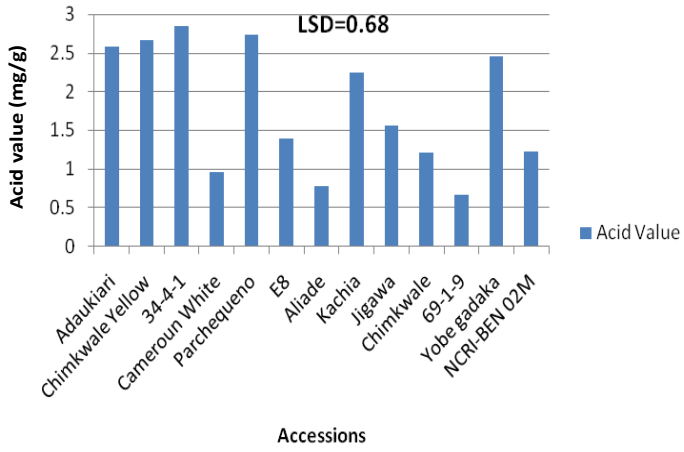

Figure 9. Acid value of the seed oil of 13 sesame accessions in 2009 experiment.

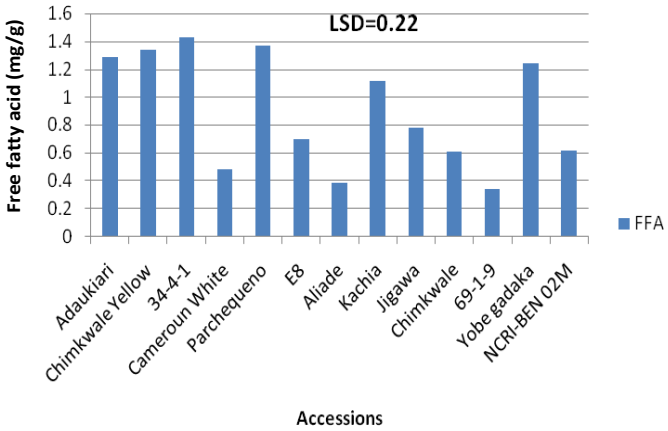

Figure 10. Free fatty acid content of seeds oil of 13 sesame accessions in 2009 experiment.

20.90 recorded among the accessions is less than 32 to 40 reported by El Khier et al. (2008).

The mean crude protein of 18.85 is also less than the mean values of 24.63, and 21.78 reported by Borchani et al. (2010), Jimoh et al. (2011). The highest value of 20.90 recorded from Parchequeno was however close to these means. Protein is very important in human nutrition and is one of the nutrients that are frequently low in plant products. Although, the mean crude fibre recorded in this study may appear to be low in accessions such as Adaukiari, Parchequeno, others like Cameroon white and Chimkwale have high crude fibre contents if compared with other reports (Jimoh et al., 2011). Fibre in diet is important as it helps to maintain human health by reducing cholesterol level in the body (Bello et al., 2008). The sesame accessions showed appreciable crude fat content. The range of 30 to 46% can be considered to be favourable when compared with results obtained by other researchers (Borchani et al., 2010; Mohammed and Hamza, 2008; Alyemeni et al., 2011).

The economic important of sesame is determined by the quantity of oil it contains. Accessions like Yobe gadaka, Kachia and Chimkwale that yielded high crude fat should be selected for production in this area, though seed yield will also be a major determinant in making a choice. The carbohydrate content of 27.63 to 44.85 in the accessions is also high when compared with the findings of El Khier et al. (2008). The ash content was within the range reported by Alyemeni et al. (2011). High level of ash makes the oilseed a good source of mineral nutrition to the consumer (Afolabi, 2008).

On the oil quality of the seed, most of the accessions fall within the acceptable standard. The range of iodine value of 76.14 to 130.07 falls within the semi-drying oil group. This conform to other findings that sesame seed oil is semi-drying oil (*Fernando* and Akujiobi, 1987). Iodine value measures the degree of unsaturation of vegetable oils (Dayrit et al., 2007). The greater the degree of unsaturation the higher the iodine value and the greater

Table 2. Chemical properties of the seeds of the 13 sesame accessions in 2010 experiment.

Accessions	Moisture (%)	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Carbohydrate (%)	Ash (%)	Iodine value (g/100 g)	Peroxide value (meq.H_2O_2)	Acid value (mg/g)	Free fatty acid (mg/g)
Adaukiari	7.00	19.17	2.25	39.00	29.70	2.88	121.40	7.50	2.48	1.30
Chimkwale yellow	6.20	19.78	1.88	34.00	35.40	2.72	106.88	4.71	2.63	1.35
34-4-1	6.22	19.80	1.84	35.00	36.00	1.14	110.04	2.52	2.78	1.41
Cameroun white	7.00	17.02	2.03	38.00	34.85	1.10	90.42	2.53	1.01	0.50
Parchequeno	6.80	21.00	2.36	36.88	31.20	1.76	103.88	4.55	2.68	1.38
E8	6.44	18.55	1.41	31.00	40.88	1.72	103.68	2.52	1.38	0.68
Aliade	6.70	19.30	1.38	32.00	38.80	1.82	110.82	2.53	0.81	0.36
Kachia	6.28	18.30	1.42	39.50	32.20	2.30	108.22	2.55	2.22	1.16
Jigawa	6.20	18.98	1.76	29.50	40.88	2.68	80.10	5.10	1.58	0.81
Chimkwale	7.80	17.56	1.98	40.15	30.10	2.41	116.30	7.88	1.24	0.66
69-1-9	5.30	18.40	1.68	27.50	45.15	1.97	118.02	5.03	0.68	0.33
Yobe gadaka	5.12	18.20	1.60	45.68	27.90	1.50	129.40	1.02	2.44	1.21
NCRI-BEN O2M	7.16	19.08	1.78	37.00	32.88	1.52	108.88	3.02	1.26	0.60
F-LSD(0.05)	1.40	0.4	0.43	4.80	8.40	0.40	10.20	1.88	0.82	0.25

the possibility of the oil becoming rancid by oxidation (Ronald and Ronald, 1989). The mean peroxide value of 3.95 recorded in the accessions falls below the maximum value of 10 meqKOH/g set by the Codex Alimentarius Commission for groundnut oil (Abayeh et al., 1998). Peroxide value is an index of rancidity in oil. It is a measure of peroxide contained in a vegetable oil (Chabiri et al., 2009).

Low rancidity indicates high resistance to peroxidation and longer storage life. The present of lignin and tocopherols (natural anti-oxidant) in sesame seed has been indicted for the resistance to oxidation which is one of the most important indicators of stable quality in edible oil (Rajaei et al., 2008; Lee et al., 2008; Cheikh-Rouhou et al., 2006).

The mean acid value of 1.79 was close to 1.64 reported by Borchani et al. (2010) and is below the maximum acceptable level of 4 mgKKOH/g oil (Hammond, 1993) and FAO maximum value of 6.0. Acid value represents free fatty acid content due to enzymatic activity and signifies spoilage in vegetable oil. Accessions such as 69-1-9 and Aliade showed acid value as low as 0.67 and 0.78, respectively presenting them as high quality oil and comparable to oil of almond nut (0.77) and groundnut (0.35) (Afolabi, 2008). The result also indicated that seed oil of these accessions are low in free fatty acid content. Free fatty acid composition is the most important parameter used in differentiating vegetable oils. High levels of free fatty acid result to unpleasant taste of the oil (Dayrit et al., 2007). The non significant differences in the chemical attributes between the two years may be attributed to the fact that the variation in weather factors in the two years was not sufficient enough to cause significant effect. Moreover the rainfall and temperature values recorded for the two years were within the range reported to be suitable for sesame production (Olowe, 2007).

Conclusion

The study has shown that the seed composition and oil quality of sesame grown in the Nsukka plain of the derived savannah agro-ecology of South Eastern Nigeria is comparable to what were obtained in the other sesame producing areas. The oil quality is as good as those of other quality vegetable oils and fall within the acceptable standard. The study also presents accession Yobe gadaka as a high oil producing type while Parchequeno is a high protein type among the accessions tested in the study area.

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