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Mineral and chemical Compositions of early and late Season Nigerian Millets

Die mineralische und chemische Zusammensetzung früh- und spätreifer nigerianischer Hirsen

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1 Introduction

Pearl millet *(Pennisetum americanum (L.)K.)* is consumed by a large segment of the population in Africa and India and attempts are being made to combine high yield attributes with nutritional quality. Like most cereal grains, pearl millet is a major source of human dietary protein in developing countries where animal protein is limited and expensive. In Nigeria, the general pattern of nutrition tends towards high level of consumption of cereals especially millets, sorghum and maize. Because of low production of wheat and rice, sorghum and millet constitute the main sources of protein in the subtropical and savanna areas of the country.

Although grown in mixtures with legumes, other cereals and cash crops, pearl millets are adapted to the adverse and limiting conditions of soils and environment (NWASIKE et al., 1982). It has therefore become one of the important cereal crops for subsistance farmers in Nigeria.

Only a few published reports are available on the chemical composition of millets grown in Nigeria (BUSSON, 1965, OYENUGA, 1968). However, these reports are based on analyses done on a few millet types of unclearly defined varieties.

Information regarding the ranges of nutrients in the various available millet varieties have not been reported. The present study was undertaken to determine the ranges in concentration of nutrients in several varieties of pearl millet grown in Nigeria with a view to identifying those with better nutritional qualities.

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2 Materials and Methods

Whole seeds of early (photo-insensitive) and late (photo-sensitive) season millets were ground in a Willey mill and protein (Nx 6,25) was determined using the microkjedahl method. Values for fat, fibre and ash were obtained by the standard AOAC procedures (HORWITZ, 1975). Carbohydrate contents were obtained by substracting the sum of the values for protein, fat, fibre and ash from 100. Sodium and potassium levels were determined by flame photometric methods while magnesium was obtained by the atomic adsoption spectrophotometric method. Iron, phosphorus and calcium were also determined by the AOAC methods (HORWITZ, 1975). Amino acid analysis involved HCL hydrohysis under reflux, with the buffered hydrolysate being run on a Technicon amino acid analyzer as given in detail elsewhere (OKOH et al., 1982).

3 Results

3.1 Proximate analysis

Protein, fat, fibre, ash and carbohydrate percent for the various millet varieties are presented in Table 1. The range of protein content in the two groups of pearl millet is wide varying from 12,38 to 17,14%.

Tab. 1: Proximate composition of millet varieties (percent of dry matter)

Varieties	Protein	Fat	Fiber	Ash	Carbo-hydrate
Early Season Millet					
Ex Borno	13.69	5.39	1.80	1.96	77.26
Ex Benue	12.38	4.60	1.66	1.84	79.52
Nigerian composite	13.06	5.80	2.26	2.33	76.55
World composite	13.06	4.02	1.37	2.02	79.53
Late Season Millet					
Ex Tukuru	17.14	4.80	2.20	2.02	73.84
Ex Riyom	16.32	5.54	1.96	2.06	74.12
Ex Gashua	14.09	5.66	1.08	2.17	77.00
Proso millet (a)	15.45	4.86	--	3.23	--
Improved Nigerian sorghum (average) (b)	11.78	2.78	2.04	1.15	82.27

(a) Average for 7 proso millet varieties (reference 3)
(b) From reference 8.

The higher protein levels are found in the photosensitive types. A relatively narrow range (4,02 - 5,8%) is observed in the fat contents. Also the ranges of values for fibre, ash and carbohydrate are narrow, 1,08 to 2,26% and 73,84 to 79,53%, respectively.

3.2 Mineral composition

Elemental analysis of the millets reported in Table 2 shows that phosphorus, magnesium and potassium are the major elements in the grain. The total phosphorus values range from 266 to 314 mg/100 g, magnesium values range from 86,5 to 126 mg/100 g and potassium from 350 to 423 mg/100 g. Similar range of values have been reported by other workers (RAO and SWAMINATHAN, 1953; SAWHNEY, 1968; KSU, 1977/78). The calcium values range from 39,0 to 50,0 mg/100 g indicating less variability than values reported by (SAWHENY, 1968). Sodium values range from 35,5 to 43,0 mg/100 g and iron values vary from 6,2 to 10,6 mg/100 g.

Tab. 2: Mineral composition of millet varieties (mg/100g)

Varieties	Na	K	Ca	Mg	Fe	P
Early Season Millet						
Ex Borno	43.0	420.0	48.5	113.0	9.0	312.0
Ex Benue	35.5	395.0	39.0	113.0	9.9	290.0
Nigerian composite	42.0	423.0	50.0	86.5	6.7	305.0
World composite	35.5	385.0	44.0	105.0	8.4	314.0
Late Season Millet						
Ex Tukuru	39.0	350.0	39.0	126.0	9.8	300.0
Ex Riyom	42.5	355.0	49.5	96.0	10.6	313.0
Ex Gashua	36.0	390.0	42.5	102.0	6.2	266.0

3.3 Amino acid composition

Results of the amino acid analysis of the different millet varieties in Table 3 show that lysine and methionine values are low as these range from 2,45 to 2,91 g/100 g protein and 1,39 to 2,05 g/100 g protein, respectively. However, the low values for methionine may be attributed to losses of this amino acid during hydrolysis of the samples by the reflux method.

The results also showed that there is little variability in the amino acid content among cultivars of pearl millet grown in Nigerian. Similar values for leucine, isoleucine, glutamic acid and other amino acids have been reported by other workers (KSU, 1977/78; FAO, 1980).

4 Discussion

Compared with other staple food crops (e.g.yam and cassava), cereals provide a much higher proportion of protein in human diets in Nigeria. Furthermore, there is an increasing utilization of Nigeria cereals for animal feeds, especially for poultry (OKOH et al.,-

Tab. 3: Amino acid composition of millet varieties

Varieties	Amino acid[1] (g/100g Protein)														
	LYS	HIS	ARG	ASP	THR	SER	GLU	PRO	GLY	ALA	VAL	MET	ILEU	LEU	TYR	PHE
Early Season Millet																
Ex Borno	2,73	3,44	4,51	8,42	4,02	4,99	19,91	6,04	3,48	8,25	5,21	2,05	4,47	11,24	3,35	5,02
Ex Benue	2,69	3,38	4,35	8,70	4,19	5,16	20,34	6,07	3,43	8,46	5,65	1,53	4,58	11,48	3,33	5,38
Nigerian composite	2,72	3,41	4,52	8,99	4,26	5,19	19,76	6,24	3,24	8,22	5,87	1,75	4,48	11,18	3,34	5,33
World composite	2,57	3,44	4,43	8,62	4,17	5,16	21,90	6,37	3,61	9,24	6,00	1,88	4,84	12,03	3,52	5,60
Late Season Millet																
Ex Tukuru	2,61	3,03	4,62	8,44	3,90	4,77	20,35	6,79	3,15	8,60	5,61	1,68	4,37	11,06	3,19	5,64
Ex Riyom	2,45	3,29	4,46	8,83	4,04	4,94	21,22	6,79	3,24	8,52	5,80	1,39	4,71	12,08	3,68	6,05
Ex Gashua	2,91	3,30	4,94	9,26	4,35	5,31	22,89	7,27	3,56	8,96	6,17	1,45	4,94	12,63	3,56	5,74
Proso millet[2]	1,41	1,84	2,98	5,77	2,90	5,91	20,48	6,76	2,17	11,14	4,92	1,89	4,23	12,94	2,45	5,44

[1] LYS = Lysine, HIS = histidine, ARG = arginine, ASP = aspatic acid, THR = threonine, SER = Serine, GLU = glutamic acid, PRO = proline, GLY = glycine, ALA = alanine, VAL = valine, MET = methionine, ILEU = isoleucine, LEU = leucine, TYR = tyrosine, PHE = phenylalanine.

[2] Average for 3 Proso millet varieties (reference 6)

1982). While maize still remains the major cereal used in animal diets, cost and availability factors are making it necessary for other cereals to be tried. Because of the extensive use of these cereals in both human and animal diets, even small proportional increase in quality have the capacity to make worthwhile differences in the quality of the diets consumend. The two groups of pearl millet herein discussed contain varying levels of protein with the photo-sensitive varieties having higher protein levels than the photo-insensitive group. The protein values reported for the photo-sensitive varieties on average are higher than the 15,45% average value reported for proso millet *(Panicum miliaceum)* varieties by LUIS (1980) and the range of 9,4 to 14,8% reported for pearl millet varieties by DAESTHALE et al. (1971).

The fat contents of the Nigerian millet varieties are similar to that reported for proso millet by LUIS (1980) and are higher than values for maize and sorghum.

The mineral of the pearl millet varieties grown in Nigeria seem low. However, they are higher in calcium and phosphorus than in maize.

Tab. 4: Comparison of essential amino acids in millet with that of sorghum and the FAO provisional pattern (g/100g protein)

Varieties	Amino acid[1]							
	LYS	THR	VAL	ILEU	MET	LEU	TYR	PHE
Early Season Millet								
Ex Borno	2,73	4,02	5,21	4,47	2,05	11,24	3,35	5,02
Ex Benue	2,69	4,19	5,65	4,58	4,53	11,48	3,33	5,38
Nigerian composite	2,72	4,26	5,87	4,48	1,75	11,18	3,34	5,33
World composite	2,57	4,17	6,00	4,84	1,88	12,03	3,52	5,60
Late Season Millet								
Ex Tukuru	2,61	3,90	5,61	4,37	1,68	11,06	3,19	5,64
Ex Riyom	2,45	4,04	5,80	4,71	1,39	12,08	3,68	6,05
Ex Gashua	2,91	4,35	6,17	4,94	1,45	12,63	3,56	5,74
Commercial sorghum (USA)[2]	2,33	3,49	5,04	3,88	--	13,10	2,90	4,94
Improved Nigerian sorghum[3]	1,92	3,42	4,81	4,05	--	13,92	4,05	5,47
FAO[4]	4,3	3,3	2,8	4,00	--	4,9	2,5	2,9

1 LYS = lysine, THR = threonine, VAL = valine, ILEU = isoleucine, MET = methionine, LEU = leucine, TYR = tyrosine, PHE = phenylalanine

2 Reference 6

3 Reference 8

4 Reference 3

The amino acid composition of the different millet varieties reported are higher in values than those reported for proso millet by LUIS (1980) in several important amino acids like lysine, histidine, arginine, threonine and valine (Table 3). Similar values were obtained for leucine, isoleucine and phenylalanine while lower values were obtained for methionine. Comparing the amino acid values with the Food and Agriculture Organisation (FAO, 1980) standard values (Table 4), it seems apparent that lysine may be the limiting amino acid in the Nigerian millet varieties. However, specific biological experiments will be needed to confirm this assertion.

5 Summary

The proximate, mineral and amino acid compositions of early and late maturing Nigerian millets have been determined. High contents of some minerals especially potassium, magnesium and phosphorus were found in all the varieties.

The total seed protein was higher in late maturing millets and ranged from 14,09 - 17,14%, while the protein in the early maturing millets ranged from 12,38 - 13,69%. Compared with improved Nigerian sorghum varieties the millets have a higher protein content and were found superior in their most limiting amino acid content (lysine).

Zusammenfassung

Von früh- und spätreifenden nigerianischen Hirsesorten wurden die Mineralstoff- und die Aminosäurezusammensetzung bestimmt. Bei allen Sorten wurden hohe Mineralstoffgehalte, insbesondere von Kali, Magnesium und Phosphor, gefunden. Der Gesamteiweißgehalt lag bei den spätreifenden Hirsesorten mit 14,09 - 17,14% TS über dem der frühreifenden Sorten, die Gehalte von 12,38 - 13,69% TS aufweisen. Im Vergleich mit verbesserten nigerianischen Sorghumsorten enthielten die Hirsen mehr Eiweiß und sie waren auch hinsichtlich des Lysingehaltes überlegen.

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