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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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A Comparative Study on Nutritional and Technological Quality of Fourteen (14) Cultivars of Pearl Millets [*Pennisetum glaucum* (L) Leeke] in Burkina Faso

*A.T. Ouattara Cheik[1], Savadogo Aly[2], Bayane Yaya[1] and Traore S. Alfred[1,2]
[1]Laboratoire de Technologie Alimentaire, [2]Laboratoire de Microbiologie et de Biotechnologie
Centre de Recherche en Sciences Biologiques, Alimentaires et Nutritionnelles (CRSBAN),
Département de Biochimie-Microbiologie (DBM), Unité de Formation et de Recherche en Sciences de la Vie et de la Terre (UFR/SVT), Universite De Ouagadougou, Burkina Faso

Abstract: A comparative study was carried out on nutritional and technological qualities of fourteen (14) cultivars of *Pennisetum glaucum* .The contents of proteins ranged from 8.66 % to 17.11 % for all the cultivars. IKMP3, IKMP5, SOSAT C88 and L Zatiib were reveled to be excellent sources of proteins. Water-soluble proteins ranged from 1.81 % to 3.18 % . Fat content in the grains values ranged from 6.76 % to 10.24 %, the best cultivars for fat were IKMP3, IKMP5, SOSAT C88 and KM. The carbohydrates are the major components of these cultivars, values ranged between 71.82 % to 81.02 % and samples IKMP1, IKMP2, TK, B1, B2 contained more carbohydrates than all others cultivars. The energy values of cutivars flours ranged from 426.21 Kcal/100g to 446.53Kcal/100g. Results of Technological properties showed capacities of swelling in water (V_I/V_F) ranged from 2.33 and 8.28. Masses of 1000 grains ranged from 5.53 g to 13.13 g; cultivars IKMV8201, IKMP5, B1 had the highest masses of 1000 grains and consequently present better outputs potential millers. Starch is present in relatively significant quantity of 51.49 % at 79.07 % and cultivars IKMP1, B1, and SG have the most raised contents. The crude fibres also are present in high quantity 8.06 % to12.40% and cultivars IKMP3, SOSAT C88 are provided greater quantity. The cultivars contents of phytates from 5.45 to 14.26 mg / g and in polyphenols from 2.27 to 3.20 mg / g. The energy values of cultivars flours lies between 426.51 kcal / 100 g and 446.53 kcal / 100 g. Samples IKMP3, IKMP5, SOSAT C88 and KM are equipped best with it. In addition, cultivars IKMP3, IKMP5, S0SAT C88, IKMV8201, KM and L Zatiib have better nutritional profiles.

Key words: Nutritional composition, physical characteristic, millets, cultivars, Burkina Faso

Introduction

Pearl millet (*Pennisetum glaucum* [L] Leeke) is one of the most important drought-tolerant cros in semi-arid-tropics regions of the world. It is a staple food in most population in Asian and African countries (Burton *et al.*, 1972). As a cereal for human food pearl millet contributes a great part of dietary nutrients for large segments of people in Africa and Asia and is often considered highly palatable and a good source of protein, minerals and energy (Abdalla *et al.*,1998a,b).

In Burkina Faso *Pennisetum glaucum* is grown as a multipurpose crop providing food (grains) in the lower rainfall area (Northern and eastern regions). The diet is characterized by a strong prevalence of cereals, mainly the sorghum and the millet .Several food preparations are made from *Pennisetum glaucum*. Burkina Faso is the third producer of pearl millet in Africa with 972 7658 tons (FAOSTAT Database results, 1999).

Pearl millet represents second cereal cultivated in Burkina after the Sorghum with 36% of the annual cereal production. It is cultivated on surroundings 40% of the cultivable grounds. Moreover, it occupies a place of choice in the eating habits in the sense that it is consumed by 90% of the rural population and 50 to 60 % of townsmen (Diawara *et al.*, 1993). It is an excellent source of energies, proteins and mineral salts.

In optic to ensure a stronger productivity of the millet and to unceasingly satisfy the request of a population in growth, the INERA (Institute of the Environment and Agricultural Research) undertook work of improvement of the cultivars of millet. This work thus made it possible to develop starting from the traditional cultivars, new cultivars more productive and more resistant to the dryness and to the attacks by the insects.

However to our knowledge, data on the nutritional and technological properties of different cultivars of pearl millets of Burkina doesn't exist .

Better a consciousness of the biochemical composition and technological properties of these cultivars would contribute to the natural selection and the development of new cultivars of better technological and nutritional qualities.

This work was undertaken to determine the technological and nutritional properties of 14 cultivars of pearl millets cultivated in Burkina.

Materials and Methods

Sampling: Our study related to 14 cultivars of collected

Table 1 : Characteristics and origins of the 14 samples of pearl millets

Name of the variety	Type	Color	Supplier	Origin (area)	
IKMV 8201	Variety	Gray yellow	INERA- ICRISAT	Mali	Center
IKMP 1	Population Variety	Yellowish	INERA- ICRISAT	BF(Kamboinsé)	Center
IKMP 2	Population Variety	Gray-yellow	INERA- ICRISAT	BF(Kamboinsé)	Center
IKMP 3	Population Variety	Gray	INERA- ICRISAT	BF(Kamboinsé)	Center
IKMP 5	Population Variety	Gray light	INERA- ICRISAT	BF(Yatenga)	Northern
SOSATC 88	Variety	Gray yellow	INERA- ICRISAT-IER	Mali	Center
L. Zatiib	Local	Gray yellow	INERA- ICRISAT	Niger	North-eastern
L. Nahartenga	Local	Yellow blade	INERA- ICRISAT	BF(Kamboinsé)	Center
TK	Local	Yellow	Trade	BF(Tenkodogo)	South-eastern
KM	Local	Gray	Trade	BF(Nouna)	North-western
B 1	Local	Yellowish	Trade	BF(Bobo-dioulasso)	Western
B 2	Local	Gray	Trade	BF(Bobo-dioulasso)	Western
SG	Local	Gray	Trade	BF(Nouna)	North-western
XX	Local	Gray	Trade	BF(Nouna)	North-western

BF = Burkina Faso

pearl millets from 4 localities: Kamboinsé (I.N.E.R.A), Bobo-Dioulasso, Nouna, and Tenkodogo.
The characteristics of these cultivars are summarized in Table 1.
The samples were directly crushed in a mill (Waring Blendor) and the corresponding flours sieved through a sieve of porosity of 1 millimeter.
The flours obtained were packed in sachets tight and were preserved at the refrigerator at -20°C.

Chemical analysis
Determination of the moisture: Moisture content was estimated by desiccation with the drying oven at 103°C (method 925-10, AOAC, 1990).

Ashes analysis: The ash content was estimated by incineration with the furnace at 550°C (method 923-03, AOAC, 1990).

Fat content: Fat content is made according to the method of extraction by the soxhlet Aa 4-38 (AOCS, 1990) by using hexane as solvent.

Proteins content: The total proteins content of the various samples were determined by the method of KJEDAHL Ba 4c-87 (AOCS, 1990).
The water-soluble proteins of the flours were determined by method AOCS Ba 11 -65 (AOCS, 1990).

Carbohydrates content: The content of total carbohydrates was determined by difference (Egan *et al*., 1981) according to the formula:
H.C (%) = 100 – [% water + % proteins + % lipids + % ashes].

Starch content (flour starch, water-soluble starch): The dosage of the starch was carried out according to spectrometric method described by Jarvis and Walker (1993).

Determination of crude fibres: The content of crude fibre was estimated by the method of insoluble formic (Deyimie *et al*., 1981).

Calculation of the energy value: The theoretical energy value of the flours was calculated starting from the analytical values for total protein, the fat content, the carbohydrates (including crude fibres) using the values of physiological energy deferred by Paul and Southgate (1985) according to the formula:
E (kJ) = 17 (kJ / G) x% total protein + 38 (kJ / G) x% fat content + 17 (kJ / G) x% glucide
Conversion into Kcal / g was carried out by multiplication by 4.184.

Analyze of anti-nutritional factors
Dosage of the phytic acid: The phytic acid content was determined by the method of Haug and Lantzsch (1983).

Dosage of polyphenols: The dosage of polyphenols was carried out by using the method described by Swain and Hillis (1959).

Flour and Grain Physical and Functional Characteristics
Mass of thousand (1000) grains: The mass of 1000 grains was determined by the counting of a sample of 1000 not damaged grains followed it's weighing.

pH and titratable acidity: The pH was given according to the potentiometric method 943,02 (AOAC, 1990) by using the electrode of a pH meter (WTW pH 526).
For the determination of titratable acidity, we proceeded by a titrimetric dosage (Obiri-Danso *et al*., 1997).

Determination of the swelling capacity of the grains: Swelling capacity of grains (CGG) was determined according to the method of Subramamian *et al*. (1986).

Table 2: Proximate composition and food energy content of 14 pearl millet cultivars

	Dry matter content %	Fats% dm	Crude proteins % dm	Water soluble proteins % dm	Starch % dm	Water soluble starch % dm	carbo-hydrates % dm	Energy kcal/100g dm
IKMV 8201	92.5±0.1	7.3±0.3	11.0±0.4	2.6±0.1	66.3±0.7	3.8±0.2	78.6	432.15
IKMP 1	89.9±01	6.9±0.2	10.2±0.7	2.4±0.0	77.3±0.9	2.6±0.6	80.6	431.84
IKMP 2	90.6±0.4	7.1±0.5	9.7±0.8	1.9±0.0	79.1±1.0	3.1±0.5	81.0	433.20
IKMP 3	93.3±0.1	9.0±0.2	15.5±0.4	2.7±0.2	53.2±1.1	2.0±0.1	72.3	438.46
IKMP 5	90.9±0.4	9.0±0.1	14.4±0.6	2.9±0.1	66.8±0.7	3.0±0.3	73.1	437.26
SOSAT C88	94.0±0.0	10.2±0.0	15.2±0.9	3.2±0.0	52.0±1.6	2.4±0.0	71.8	446.53
Zatib	91.2±0.1	6.9±0.3	17.1±0.2	3.1±0.1	51.5±1.3	1.8±0.4	73.2	429.25
Nahartenga	93.6±0.1	6.8±0.2	12.5±0.2	2.4±0.0	59.0±0.9	3.8±0.1	77.4	426.51
TK	94.0±0.1	7.2±0.1	9.0±0.4	2.3±0.1	65.2±1.4	2.5±0.3	80.9	430.14
B 1	89.5±0.1	7.8±0.3	9.3±0.4	1.8±0.3	74.7±1.0	2.7±0.2	80.4	435.66
B 2	90.9±0.0	7.7±0.1	8.7±0.3	1.9±0.0	69.8±0.9	2.7±0.5	80.4	431.71
KM	93.5±0.1	8.4±0.1	11.4±0.9	2.3±0.4	63.5±0.9	2.8±0.6	77.9	439.14
SG	93.4±0.1	7.4±0.0	11.2±0.7	2.6±0.3	75.7±1.0	1.9±0.4	79.1	434.38
XX	93.4±0.0	7.6±0.0	10.9±0.4	3.2±0.0	64.4±0.9	3.4±0.2	79.3	435.44

dm= dry matter

Determination of the swelling capacity of the flours: The swelling capacity of flour (CGF) was given according to the method of Subramamian *et al.* (1986). The values (CGF) was expressed by the report/ratio from final volume (Vf) / initial volume (Vi) or of masses Mf / Mi.

Determination of the water-soluble fraction of the flours: The soluble fraction of the flours in water (FSEF) was given according to the method of Subramamian *et al.* (1986). Results were expressed by the water-soluble fraction of flour (FSEF) in mg for 100 g of flour.

Results and Discussion

Water contents of the samples: The water contents of the various samples of flours were summarized in Fig. 1. The water contents of the flours vary between 5.97 % (SOSAT C 88) and 10.47 % (B1). The average of the unit is 7.80 % ± 1.55. The highest level of moisture were obtained with the samples B1 (10.47 %), IKMP1 (10.08 %), IKMP2 (9.39 %), B2 (9.15 %), IKMP5 (9.05 %), and L Zatiib (8.82 %); while the lowest contents were obtained with cultivars IKMP3 (6.65 %), XX (6.63 %), SG (6.59 %), KM (6.52 %), L Nahartenga (6.43 %), TK (6.04 %) and SOSAT C 88 (5.97 %). Finally sample IKMV 8201 has a level means of 7.48 %. This level is close to the average of the whole of the samples. These contents lie between those reported in Nigeria by Salami and Okezie (1994) and those observed in Sudan by Abdalla *et al.* (1998b). These differences in water contents according to the various samples of flours can be explained on the one hand by climatic variations, farming and of storages conditions of the grains of millets (moisture of the air and temperature) and other share by the genetic factors the such size of the grain. Nevertheless this water content should not be higher than 16 % because the water content of the grains is a significant condition of the good conservation of the flours (Colas, 1998). A high level of moisture involves the development of micro-organisms (yeasts and moulds) and led to an acceleration of the reactions of flour deteriorations.

Ashes contents: The ashes contents of the 14 samples of flours are indicated in Fig. 2. The ash contents ranged between 2.16% (XX) and 3.44 % (IKMP5) with an overall average of 2.76 % ± 0.45. Analysis of these results showed that samples IKMP5 (3.44 %), L Nahartenga (3.41 %), B2 (3.28 %) and IKMP3 (3.41 %) present the highest ashes contents (higher than 3 %). While cultivars IKMV 8201 (3 %), TK (2.95 %), L Zatiib (2.86 %) and SOSAT C88 (2.71 %) have level close relations of the overall average. Finally the lowest ashes contents were raised with the cultivars IKMP1 (2.45 %), B1 (2.35 %), KM (2.33 %), IKMP2 (2.23 %), SG (2.21 %) and the XX (2.16 %). Contents observed differ from those reported by Abdalla *et al.* (1998b) and by Singh *et al.* (1987). These differences in ashes content are certainly due to the environmental conditions.

Fat contents of the samples: The fat contents of the various flours are presented in Table 2. The fat contents vary between 6.76 % (L Nahartenga) to 10.24 % (SOSAT C 88), with an overall average of 7.81 % ± 0.97. The fat contents highest were observed with samples SOSAT C88 (10.24 %), IKMP3 (9.02 %), IKMP5 (8.99 %) and KM (8.42 %). While the samples B1 (7.84 %), B2 (7.70 %), XX (7.56 %), IKMV 8201 (7.35 %), TK (7.16 %), IKMP2 (7.12 %), L Zatiib (6.87 %) and L. Nahartenga (6.76 %) have fat contents less.

Similar results were also reported by Jain and Bal (1997). Comparatively with other cereals, the flours of millets are rich in fat; that is primarily due to the structure of the grain of millet which has its germ (very rich in fat) related to the endosperm; so that during grinding it is not possible to dissociate them (Jelum and Powell, 1971;

Table 3: Energy values and distribution of the total energy of the 14 samples of flours

	Energy value for 100 g of flour		Contribution to the energy value of the principal components of total energy (%)		
	kilojoules	kilocalories	Glucides	Lipids	Proteins
IKMV 8201	1808.11	432.15	73.93	15.45	10.37
IKMP 1	1806.82	431.84	75.87	14.51	9.62
IKMP 2	1812.50	433.20	75.99	14.93	9.02
IKMP 3	1834.51	438.46	66.98	18.68	14.34
IKMP 5	1829.49	437.26	67.93	18.67	13.86
SOSAT C-88	1868.29	446.53	65.35	20.83	13.82
L.Zatiib	1795.99	429.25	69.27	14.54	16.19
Lnahartenga	1784.50	426.51	73.73	14.39	11.87
TK	1799.7	430.14	76.38	15.12	8.50
KM	1837.38	439.14	72.06	17.41	10.53
B1	1822.82	435.66	75.00	16.34	8.65
B2	1806.28	431.71	75.65	16.20	8.15
SG	1817.44	434.38	73.96	15.53	10.50
XX	1821.87	435.44	74.04	15.77	10.19

De Francisco *et al.*, 1982).). However this strong wealth of lipids limits the conservation of the flour of millets due to hydrolyses and oxidations reactions (rancidity) of the lipids during storage.

Proteins contents of millets: Table 2 gives the composition of the various water-soluble proteins and total proteins of flours. The total proteins contents of the various samples ranged between 8.66 % (B2) and 17.11 % (L Zatiib), with an overall average of 11.86 % ± 2.48. The highest contents of proteins were noted with the cultivars L Zatiib (17.11 %), IKMP3 (15.47 %), SOSAT C88 (15.15 %) and IKMP5 (14.,42 %). The lowest contents of total proteins were obtained with samples IKMP1 (10.22 %), IKMP2 (9.66 %), B1 (9.28 %), TK (9.00 %) and B2 (8.66 %). Cultivars L Nahartenga (12.46 %), KM (11.38 %), SG (11.23 %), IKMV 8201 (11.03 %), and XX (10.92 %) presented protein contents close to the average.

The results observed are similar to those obtained by Subramanian *et al.* (1986) on Indian cultivars and with those obtained by Abdalla *et al.* (1998b) on Sudanese cultivars. Comparatively with total proteins contents, the variations of the water soluble proteins contents of the flours are weak. The contents ranged between 1.81 % (B1) and 3.18 % (XX) with an overall average of 2.53 % ± 0.46. The samples of XX (3.18 %), SOSAT C88 (3.16 %), L Zatiib (3.14 %) and IKMP5 (2.91%) presented the most contents water-soluble proteins, while B1 (1.81 %), B2 (1.87 %) and IKMP2 (1.88 %) presented the lowest contents of water-soluble proteins. These contents are different from those reported by Subramanian *et al.* (1986). This difference observed could be due to a greater proportion of the albumin fraction (fraction water soluble, rich in basic lysine and other amino acids) of our flours and / or to a better availability of flour proteins free amino acids. The presence of proteins or the amino acids in the aqueous medium is favorable for the nutritional quality of the millet because the quality of proteins of a food depends not only on its composition in amino acids but also on the availability of those (Hamad and Fields, 1979). Moreover observations of Subramanian *et al.* (1986) showed that there is a positive correlation between the water-soluble mille proteins content and the sensory quality of the meals.

Carbohydrates contents of the various samples of flours: Table 2 gives the carbohydrates content of all cultivars. The analysis of these results shows that the contents of carbohydrates ranged between 71.8% (SOSAT C88) and 81.0% (IKMP2), that is to say an overall average of 77.57 % ± 3.33. Samples IKMP2 (81.0 %), TK (80.9 %), IKMP1 (80.6 %), B1 (80.4 %) and B2 (80.4 %) present the highest contents of carbohydrates. While the cultivars L Zatiib (73.2 %), IKMP5 (73.1 %), IKMP3 (72.3 %) and SOSAT C88 (71.8 %) have the lowest contents of carbohydrates. Cultivars XX (79.4 %), SG (79.1 %), IKMV8201 (78.6 %), KM (77.9 %) and L Nahartenga (77.4 %) have level of carbohydrates close to the level means. These values in spite of their fluctuations remain rather high and are similar to that observed in Nigeria by Salami and Okezie (1994).

Table 2 gives the contents of water-soluble starch and total starch in flours. Compared to the total carbohydrate, the starch contents are much more variable on the whole cultivars. The contents of starch ranged between 51.5 % (L Zatiib) and 79.1 % (IKMP2) for an overall average of 65.6 % ± 8.90. The analysis of this variation made it possible to distinguish from the samples with raised contents, the samples with low contents and others with average contents.

- the samples with high contents are composed of: IKMP2 (79.1 %), IKMP1 (77.3 %), SG (75.7 %) and B1 (74.7 %),
- those with low contents are composed of: L Nahartenga (59.0%), IKMP3 (53.2%), SOSAT C88 (52.0%) and L Zatiib. (51.5 %).

Except the contents of samples IKMP2, IKMP1, SG and B1, the contents observed are similar to those observed by Abdalla *et al.* (1998b) and by Hoover *et al.* (1996).
The contents of water soluble starch varies between 1.8 % (L Zatiib) and 3.8 % (IKMV 8201), for an overall average of 2.8 % ± 0.61. The samples of IKMV 8201 (3.8 %), L Nahartenga (3.8 %) and XX (3.4 %) present the highest contents of water-soluble starch. Cultivars IKMP3 (2.0 %), SG (1.9 %) and L Zatiib (1.8 %) have the lowest contents. Cultivars IKMP1, IKMP2, IKMP5, SOSAT C88, TK, KM, B1 and B2 have contents close to the level means.

Energy value of cultivars flours: The energy values of the flours (Table 2) ranged between 426.51 Kcal / 100 g (L Nahartenga) and 446.53 Kcal / 100 g (SOSAT C88); that is to say an overall average of 434.37 ± 4.80 Kcal / 100 g. Analysis of these results shows that samples SOSAT C88 (446.53 Kcal / 100 g), KM (439.14 Kcal / 100 g), IKMP3 (438.46 Kcal / 100 g), IKMP5 (437.26 Kcal / 100 g) present the highest energy values. The actual values ranged between those observed by Singh *et al.* (1987) and those reported by Salami and Okezie (1994). The principal role of the millet in the diet of million people is to ensure the energy requirements by its contribution in calories of carbohydrates origin. The distribution of this energy (Table 3) shows well that the carbohydrates are the principal source of calories. Energies of carbohydrates lie between 65.35 % (SOSAT C88) and 76 % (IKMP2).
The lipids contribute because of their high-energy capacity (2 times that of the carbohydrates) for a considerable share to the total energy of the flour of the millet. In effect, it was observed an energy contribution of lipidic origin varying between 14.39 % (L Nahartenga) and 20.83 % (SOSAT C88). The analysis of the distribution of energy shows that there is a positive correlation (r = + 0.92) between the content of lipids and the total energy of the flours. Thus the sample of SOSAT C88 although presenting the lowest content of glucide is the sample that has the strongest energy value of shares its wealth of lipids (20.83 % of the energy value). It is the same for KM (17.41 %), IKMP3 (18.68 %) and IKMP5 (18.67 %). On the other hand the samples whose lipidic contributions to total energy are weak, have the weakest energy values. Are in this case the samples of L Nahartenga (14.39 % of the energy value), of TK (15.12 %) and L Zatiib (14.54 %).
The contribution of proteins to the energy of the flours lies between 8.15 % (B2) and 16.19 % (L Zatiib). This contribution is weak but a remains appreciable insofar as the function of proteins in a food is first to ensure requirements in amino-acids. We notice also that the samples of IKMP3, IKMP5 and SOSAT C 88 present not only one good supplier in energy of carbohydrate and lipidic origin but also of good proportions of proteins.
The distribution of the energy contribution described by Agbessi and Damon (1987) recommends that a balanced food bring approximately 15 to 25 % of energy of lipidic origin, 65 to 75 % of energy of carbohydrate origin, 7 to 12 % of energy of proteinic origin. However, it is necessary to make the difference between foods ready to eat and food ingredients entering preparation. The millet not being consumed in flour state, a new equilibrium could be established with the preparation and the addition of other ingredients.

Contents of crude fibres: The contents of crude fibres of the various samples of flours are summarized in Fig. 3. These contents vary between 8.06 % (IKMP1) and 12.40 % (SOSAT C88), are an overall average of 9.64 % ± 1.08. Samples SOSAT C88 (12.40 %) and IKMP3 (11.25 %) have the contents most raised of crude fibres, while the lowest contents were obtained with cultivars TK (8.78 %), L Zatiib (8.35 %) and IKMP1 (8.06 %). These results differ from those observed by Singh *et al.* (1987) and Abdalla *et al.* (1998a,b). Strong proportions of celluloses and lignins of the grains of millet explain the level rose out of fibres and also by the fact that the grains did not undergo dehulling

Contents of anti-nutritional factors

Contents of phytate: Table 4 gives the contents of phytic acid of the various samples of millet. The contents ranged between 5.4 mg / g (B2) and 14.3 mg / g (L Zatiib), with an overall average of 9.61 mg / g ± 2.,48.
The highest contents of phytic acid were obtained with the samples of L Zatiib (14.3 mg / g), IKMP3 (12.6 mg / g), TK (12.3 mg / g), IKMV 8201 (11.4 mg / g) and SOSATC88 (11.4 mg / g). The lowest phytic acid contents were observed with cultivars IKMP5 (8.9 mg / g), IKMP2 (8.4 mg / g), L Nahartenga (7.6 mg / g), XX (7.3 mg / g), B1 (6.0 mg / g) and B2 (5.4 mg / g). Except the contents of the cultivars L. Zatiib, IKMP3, TK, IKMV 8201 and SOSATC88, the results observed are similar to those brought back by Abdalla *et al.* (1998 a and b) and by Kheterpaul and Chauhan (1991). These high percentages of phytic acid are generally due to a whole of environmental and genetic conditions (Simwemba *et al.*, 1984) in particular with strong concentrations of phosphorus in the ground (Abdalla *et al.*, 1998a,b; Raboy *et al.*, 1991; Miller *et al.*, 1980).

Contents of polyphenols: The contents polyphenols of the millet samples of flours are indicated in Table 4. The contents ranged between 2.3 mg / g (IKMP2) and 3.2 mg / g (L Zatiib), and have an average of 2.69 mg / . ± 0.26. The variation of the polyphenols content is weak. Nevertheless we note that the cultivars L Zatiib (3.2 mg / g), IKMP3 (3.0 mg / g), IKMV 8201 (2.6 mg / g) and L Nahartenga (2.9 mg / g) present the highest contents. While the lowest values were observed with samples

Table 4: Phytic acid and polyphenols of 14 cultivars of millets

	phytic acid mg / g dm	polyphenols mg / g dm
IKMV 8201	11.4 ± 0.3	2.6 ± 0.1
IKMP 1	9.7 ± 0.2	2.4 ± 0.0
IKMP 2	8.4 ± 0.2	2.3 ± 0.1
IKMP 3	12.6 ± 0.3	3.0 ± 0.2
IKMP 5	8.9 ± 0.0	2.6 ± 0.2
SOSAT C88	11.4 ± 0.1	2.7 ± 0.1
Zatib	14.3 ± 0.4	3.2 ± 0.1
L. Nahartenga	7.6 ± 0.4	2.9 ± 0.2
TK	12.3 ± 0.3	2.5 ± 0.1
B 1	6.0 ± 0.2	2.4 ± 0.2
B 2	5.4 ± 0.3	2.7 ± 0,2
KM	9.3 ± 0.3	2.8 ± 0.1
SG	9.9 ± 0.2	2.5 ± 0.2
XX	7.3 ± 0.3	2.6 ± 0.1

dm = dry matter

Table 5: pH and acidity of 14 cultivars of millets

	pH	titratable acidity (% of lactic acid)
IKMV 8201	5.88 ± 0.02	1.11 ± 0.08
IKMP 1	5.78 ± 0.10	0.95 ± 0.02
IKMP 2	5.85 ± 0.08	0.83 ± 0.09
IKMP 3	6.37 ± 0.02	0.68 ± 0.07
IKMP 5	5.90 ± 0.02	0.79 ± 0.02
SOSAT C 88	6.11 ± 0.01	0.66 ± 0.04
L. Zatiib	6.14 ± 0.02	0.65 ± 0.06
L. Nahartenga	6.25 ± 0.02	0.59 ± 0.12
TK	6.26 ± 0.01	0.50 ± 0.03
KM	6.23 ± 0.03	1.14 ± 0.13
B1	5.90 ± 0.13	0.80 ± 0.04
B2	5.91 ± 0.04	0.76 ± 0.01
SG	6.17 ± 0.01	1.09 ± 0.04
XX	6.37 ± 0.02	0.80 ± 0.12
Mean value	6.07 ± 0.18	0.81 ± 0.19

KM (2.8 mg / g), SOSAT C88 (2,7 mg / g), B2 (2.7 mg / g), IKMP5 (2.6 mg / g), XX (2.6 mg / g), SG (2.5 mg / g), TK (2.5 mg / g), B1 (2.4 mg / g), IKMP1 (2.4 mg / g) and IKMP2 (2.3 mg / g). Our results are as a whole different from those observed by Kheterpaul and Chauhan (1991) which brought back contents more raised about 7.6 to 7.6 mg / g.

The overall analysis of the anti-nutritional factors (polyphenols and phytate) shows that the cultivars L Zatiib, IKMP3, IKMV 8201 and SOSAT C88 present the highest contents of phytate and polyphenols. The cultivars of IKMP1, IKMP5, KM, SG and L Nahartenga present contents relatively less low of phytates and low contents polyphenols while the cultivars IKMP2, B1, B2 and XX have the lowest contents of polyphenols and phytates.

The phytates and polyphenols are compounds naturally present in the grains of cereals (Chauhan *et al.,* 1986; Mahajan and Chaulian, 1987). They affect the bioavailability of the minerals (Reddy *et al.*, l982; Harland and Oberleas, 1987; Pushpanjali and Khokhar,

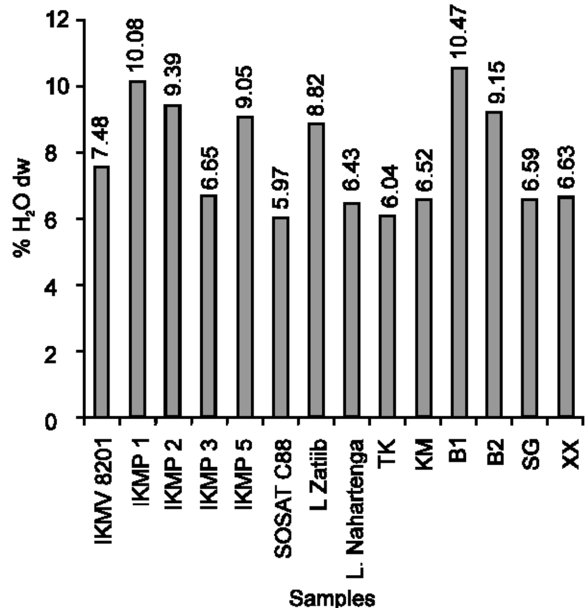

Fig. 1: Moisture

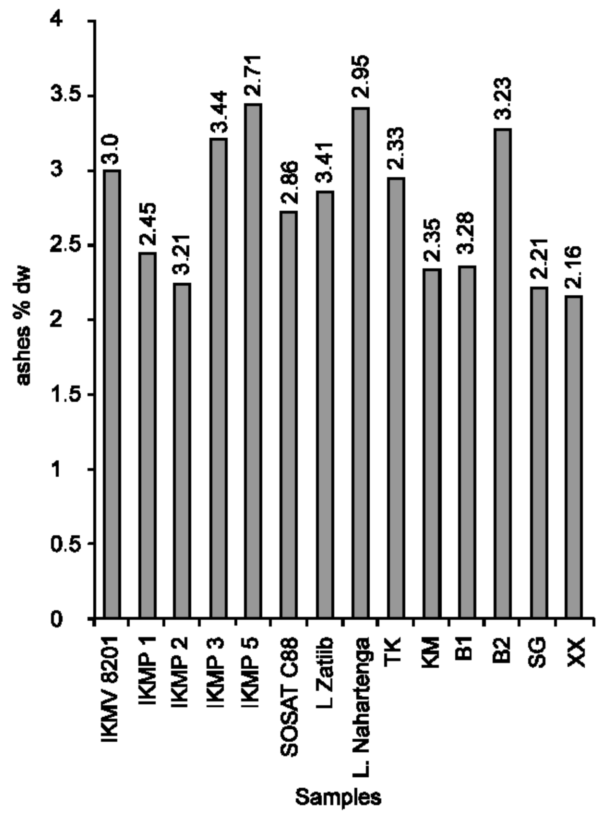

Fig. 2: Ashes contents

1996; Duodu *et al.,* 1999; Lonnerdal, 2000), the digestibility of carbohydrates (Sripriya *et al.,* 1997; Carnovale *et al.,* 1988; Yoon *et al.,* 1983) and inhibit the activity of proteolytic and amylolytic enzymes (Knuckles *et al.*, 1985; Sharma *et al.*, 1978; Elmaki *et al.*, 1999; Elkalil *et al.*, 2001). The nutritional quality of the meals from millets can be improved by reducing the level of these factors. Traditionally the operations of steeping, dehulling, fermentation and germination make it possible to reduce the level of these factors.

Technological qualities of cultivars

pH and titratable acidity: Table 5 gives the values of the pH and the titratable acidity of the various samples. The pH of the various flours lie between 5.78 (IKMP1) and 6.37 (IKMP3) with an average of 6.07 ± 0.18. Just like the pH, acidities vary very little and are located between 0.5 % of lactic acid (TK) and 1.14 % of lactic acid (KM). These low acidities indicate a good quality of harvests. It is mainly due to the acidity of the fatty acids formed by hydrolysis or oxidation of the lipids. A strong acidity results from the rancidity of the flours and thus a nutritional reduction of the value.

Masses of 1000 grains of millets: The masses of 1000 grains were represented in Fig. 4. The masses of 1000 grains of the cultivars of millets ranged between 5.63 g (L. Zatiib) and 13.13 g (B1) with an average of 8.66 ± 1.97 g. The highest masses were recorded with the cultivars B1 (13.13 g), IKMV8201 (10.89 g) and IKMP5 (10.69 g), while cultivars KM (7.56 g), SG (7.46 g), TK. (6.60 g), L Nahartenga (5.89 g) and L Zatiib (5.63 g) have the lowest masses of 1000 grains.

These results are in the range of the values observed (2.5 g to 14 g) in general for pearl millets (FAO, 1995). The mass of thousand grains is a varietal characteristic that is influenced by the size of the grains. It is in close connection with the size of the grains, which expresses it indirectly. Consequently, it influences the outputs in flours or out of semolina of the grains because of the report/ratio surfaces (envelope) / volume (endosperm). The bulkiest grains having the highest outputs in flours (Godon, 1998). In fact the mass of thousand grains allows previewing the output in flour of the cereal grains. Therefore will be able it to allow according to observations of Kairwal *et al.* (1997) of previewing cooking times of the grains of millets. Kairwal *et al.* (1997) observed that there is a positive correlation between the time of cooking and the mass of thousand grains of various cultivars of millets.

Water soluble Fractions of the flours: The values of the Soluble Fractions of the Flour in Water (FSFE) are presented in Fig. 5. These values ranged between 17.1 mg / 100 g (TK) and 49.9 mg / 100 g (B1), the average of the unit accounting for 29.2 mg / 100 g ± 9.47. These results are different from those reported by Subramanian *et al.* (1986) which for a whole of 20 cultivars observed a variation from 23.7 to 63.6 mg/100g.

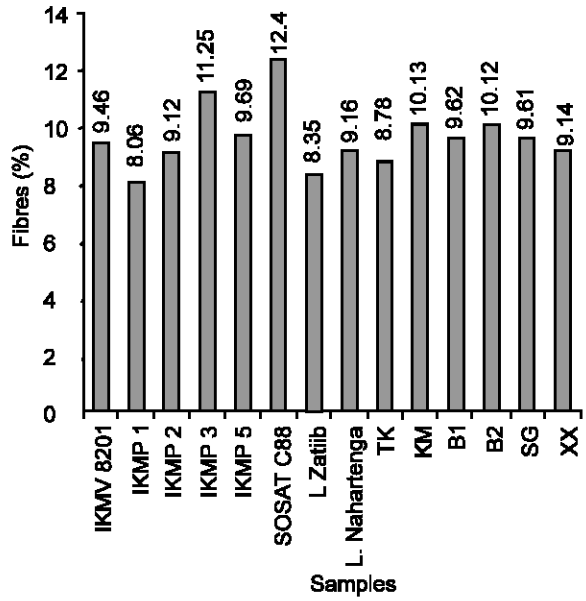

Fig. 3: Fibres content of 14 millet cultivars

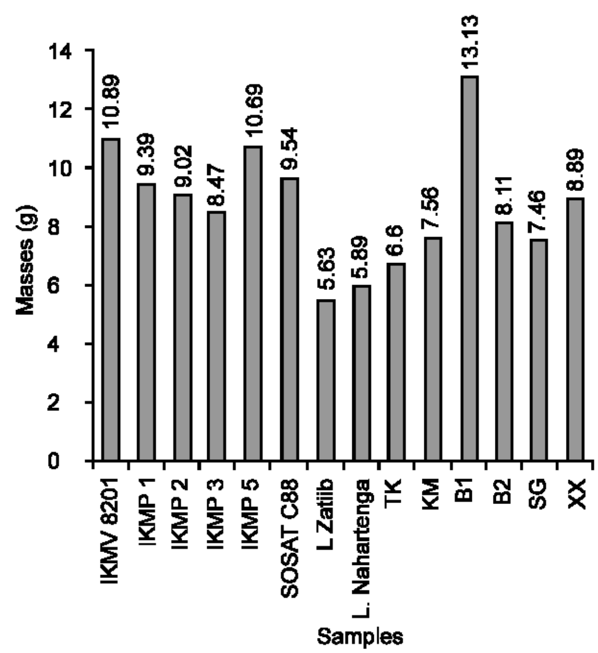

Fig. 4: Masses of 1000 grains of 14 millets cultivars

Swelling capacities of grains and flours of millets: Swelling Capacities of Grains (CGG) and Flour (CGF) of the various samples of millets were presented in Fig. 6. The capacities of swelling of the flours (V_f /Vi) ranged between 2.33 (IKMV 8201) and 8.28 (L Zatiib), with an overall average of 5.65 ± 1.71. The analysis of these results shows that flours of cultivars IKMP5 (4.06), XX (4), IKMP2 (3.19) and IKMV8201 (2.33) present the lowest swelling capacities, while the flours of the cultivars L Zatiib (8.28), TK (8) and B2 (7.43) have the highest swelling capacities.

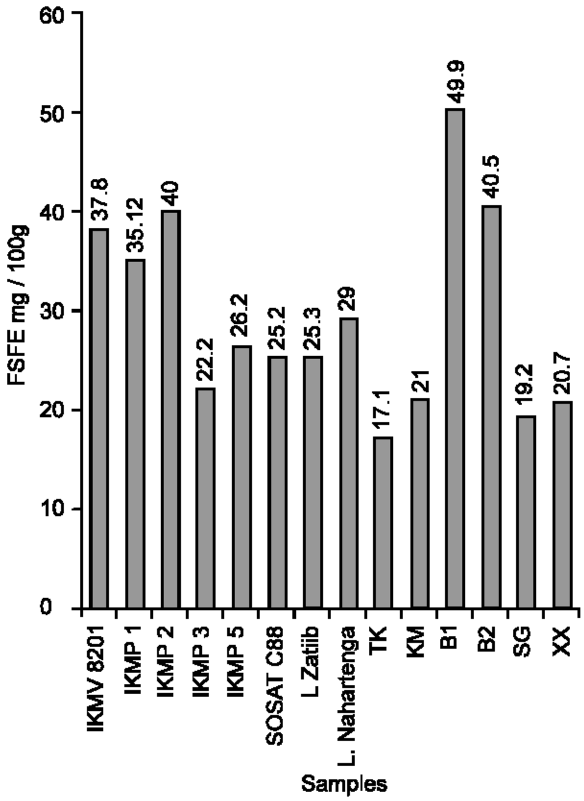

Fig. 5: Water soluble fractions of the flours

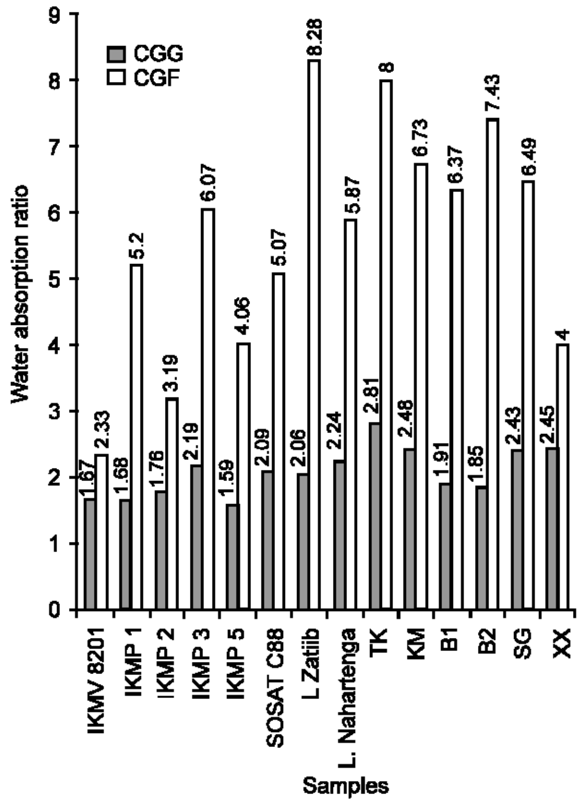

Fig. 6: Swelling capacities of grains and flour of 14 millets cultivars

Results obtained are different from those brought back by Subramanian et *al*. (1986), which observed lower swelling capacities. In the light of these observations we can deduce that the flours, which we studied, have good swelling aptitudes.

The swelling capacity of the flours translates the property of the starch of the flours to absorb water and to be gelatinized. It is influenced in fact by the physicochemical properties of the starch. In effect this capacity of the starch to absorb water is influenced by the connection of the amylosic chains with lipidic chains and by the shape and the proportion of the starch granules (Hoover *et al.*, 1996); amorphous starch having a capacity of absorption of water higher than the crystalline starch (FAO, 1995). This property has an importance in the technology of the meals cooked with water in the sense that it affects the textural characteristics prepared food.

Subramamian *et al.* (1981) observed that there is a positive correlation between the swelling capacity of flours and proteins as well as water-soluble amylose. They observed also that the swelling capacity of the flour jointly with other factors (fat, amylose, mineral, sugar) have an influence on the sensory quality of the millet.

The swelling capacity of grains (m_F / m_I) varies from 1.59 (IKMP5) to 2.81 (TK). The results obtained are similar to those reported by Subramanian *et al.* (1986). Compared to the flour we note for the grains, a weak variation of the swelling capacity. However cultivars TK (2.81), KM (2.48), SG (2.43), XX (2.45), L Nahartenga (2.24) and IKMP3 (2.19) have swelling capacity slightly higher than the average. This low swelling capacity could be due to the structure of the grains, which would limit the water absorption. The presence of the certain hydrophobic elements such as lipidic chains and hydrophobic amino acids reduces this absorption.

Conclusion: The comparative study of the nutritional and technological qualities of 14 cultivars of *Pennisetum glaucum* showed variations of the biochemical composition from one variety to another.

The analysis of the biochemical composition showed that the mineral level of the whole of the 14 cultivars of millets lies between 2.16 % and 3.44 %. The energy values of the various flours ranged between 426,,51 kcal / 100 g and 446.53 kcal / 100 g.

Cultivars IKMP3, IKMP5, S0SAT C88, IKMV8201, KM and L Zatiib have better nutritional profiles. These cultivars have energy levels higher than 429 kcal / 100 g, contents of proteins and mineral respectively higher than 11 % and 2.33 %. Their vulgarization and their incorporations in the diet of the populations can contribute to the reduction of proteino-energetic malnutrition and the micronutrients deficiencies.

However some cultivars present the highest contents of anti-nutritional factors as phytates (> 11.37 mg / g) and polyphenols (> 2.75 mg / g) although the whole of the cultivars is equipped with it. It is then necessary to reduce these factors to improve and ensure a good nutritional quality of the meals. Treatments like steeping, fermentation, germination and cooking can be planned in our later studies to reduce the level of these factors.

All these results constitute a database, which makes it possible to assess the nutritional and technological qualities of various cultivars of pearl millets, and can be used in the establishment of a food table of composition of Burkina. Also, can the programmes of agronomic research use them and nutritional in visual sense to provide food of high nutritional values adapted to the tastes of the populations.

This study allowed determinant the nutritional and technological properties of the 14 cultivars of pearl millets and to select those of them presenting of better profiles. The continuation of work will result in widening the field of study on the one hand on the biochemical composition while proceeding to analyses of rock salt, vitamins, essential amino acids and bio availability of these elements; in addition to evaluate the effects of certain traditional technological treatments on the reduction of the anti-nutritional factors in visual sense to improve the digestibility of the finished products.

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