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Research Article

Evaluation of Nutritional Composition of Nepalese Finger Millet (*Elusine Coracana* L.)

Kunjal Shrestha* and Dhan Bahadur Karki

Central Campus of Technology, Tribhuvan University, Dharan, Nepal

***Corresponding Author:** Kunjal Shrestha, Central Campus of Technology, Tribhuvan University, Dharan, Nepal.

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Abstract

The present investigation was carried out to study the proximate composition, micronutrients and changes in anti - nutritional factors after germination of six different Nepalese finger millet varieties (Dalle, Kabre, Okhale, GPU-0025, GE-5016 and GE-0116) which were collected form "National Hill Crop Research (NHCR) Center", Dolakha Kabre. Out of this six varieties, three (i.e. Dalle, Kabre and OKhale were natural varieties while other three (i.e. GPU-0025, GE5016 and GE-0116) were tube varieties. Germination of millet seeds was carried at 28 ± 2ºC for 3 days and changes in its anti - nutritional contents (phytic acid, total polyphenols, tannins, total flavonoids and total oxalates) and reducing sugar content were analyzed.

The protein, crude fat, crude fibre, total ash and moisture contents of all six varieties were found to be in the range of 6.8 - 7.3%, 1.3 - 1.7%, 2.8 - 3.33%, 1.9 - 2.2% and 13.2 - 14.5% on dry basis respectively. Starch content ranged from 59.8 - 60.3% dry basis on an average for all six varieties. Minerals such as calcium, phosphorus, iron, zinc, sodium and potassium were determined. In these different varieties, calcium content was found in the range of 340 - 400 mg/100g, phosphorus 230 - 285 mg/100g, iron 4 - 7.3 mg/100g, zinc 1.7 - 2.7 mg/100g, sodium 0.60.95 mg/100g and potassium 620 - 1140 mg/100g. Germination of millet seeds for 3 days significantly decreased all anti - nutritional factors except for tannin. Phytic acid content ranged from 520 - 615 mg/100g dry matter before germination which reduced to 140 - 230 mg/100g dry matter after germination, total oxalates ranged from 20.5 - 22.84 mg/100g dry matter before germination which reduced to 9.4 - 11.8 mg/100g dry matter after germination, total polyphenols ranged from 334 - 377 mg/100g dry matter which was reduced to 130 - 179 mg/100g after germination and total flavonoids content ranged from 93 - 144mg/100g which reduced to 81 - 113 mg/100g dry matter on germination. While tannin contents increased after germination 285 - 394 mg/100g dry matter from 212 - 322 mg/100g dry matter and reducing sugar increased by 13 - 15 fold.

The study showed that the germination of grain significantly reduced the anti - nutritional content of the grain except for tannins thereby increasing the bio - accessibility of minerals in diet.

Keywords: Finger Millet; Crude Fat; Sugar

Introduction

Millets are rapid growing; warm weather cereals grasses of several species, whose small grain are used as food. Millets are major part of the diet of 250 million of poorer people living in poorer, drier lands in India, China, Russia and elsewhere [1].

Elusine coracana is a tall grass that is also known as Finger millet. Finger millet can be ground and cooked into cakes, puddings or porridge. The grain is made into a fermented drink (or beer) in many parts of Africa. The straw from finger millet is used as animal fodder. It is also used for as a flavoured drink in festivals.

Consumption of finger millet is good for the people suffering from heart attack, blood pressure and sugar disease (personal contact Deepak Parsad Tiwari, 2009). Finger millet has good source of Mg, K, Na and irons. Magnesium has been shown in studies to reduce the severity of asthma and to reduce the frequency of migraine attacks. Millet flour is also used for anti-allergic, measles; ghamaura and bone fracture. Kumal offered the millet recipes to good indispensable item to their Kulayan god worship in the month of magha [2].

Finger millet contains some of the antinutrients (the chemical constituents of seeds which effect the utilization of nutrients)

such as polyphenols, phytates and some of the enzyme inhibitors to some extent. However, when the millet is milled and the outer bran is separated, the concentration of polyphenols and phytates is reduced and when the material is heat treated to prepare food, the enzyme inhibitors are destroyed. So, in general, the antinutritional factors are not a major problem at all, in case of finger millet [3].

When seeds are placed in an environment favorable to germinate, the rate of metabolism is markedly accelerated. The reactions taking place include hydrolysis, oxidation, desmolysis and synthesis. Stored food is changed from insoluble, immovable to soluble, transportable compounds. With these soluble compounds as building blocks, the embryos can synthesize compounds needed for the manufacture of new tissues. There is a great increase in enzyme activity of seeds during germination, carbohydrates, proteinases, lipases, oxidases and desmolases are active in germinating seeds [4].

Respiration almost increases almost immediately upon inbibition and continues to increase for around 12 hrs. This respiration is independent of protein synthesis but is dependent on substrate stored on the embryonic axis. The initiative respiratory substrate may be free amino acids, and sugars stored in the dry embryo. Later there are more hexose produced from starch, protein and lipids. After the initial germination stages, stores in the cotyledons or endosperm declines as these materials are digested and transported to the growing axis and these are oxidized or assimilated. In the embryo axis itself the levels of soluble sugars may decline with rapid utilization and then rise after several days when the seedling becomes photo synthetically competent.

About 12 hrs, after imbibition, there is a lag in the rate of oxygen consumption, water uptake and ATP level. The time between the lag period and subsequent events such as cell division or radicle emergence varies in different species [5].

Materials and Method

Raw material collection

Different varieties of finger millet were collected from National Hills Crop Research Program, Kabre, Dolakha. Varieties included 500g of each kabre, dalle, okhale, GE - 0116, GPU - 0025 and GE - 5016 which were packed in muslin cloth bags and stored at a room temperature.

Determination of minerals

The minerals content in six different varieties of Nepalese finger millet were determined as described by Rangana [6]. Minerals such as calcium, sodium, potassium, iron, phosphorus, zinc and manganese were determined.

Determination of dry matter loss

The soaked millet samples were dried, and its moisture content was determined by hot air method as described by Rangana [6].

Determination of phytic acid

The phytic acid was extracted with trichloroacetic acid and precipitated as ferric salt. The iron content of the precipitate was determined colorimetrically and the phytate phosphorous content calculated from this value assuming a constant 4 Fe: 6 P molecular ratios in the precipitate, as described in Sadasivam S. and Manickam A [7]. The mg iron present in $Fe(NO_3)_3$ was calibrated from the standard curve.

Determination of tannin

Tannin was determined by Folin - Denis method as described by Sadasivan S. and Manickam A [7] 1g ground millet sample with 50 ml distilled water was boiled for 30 minutes, the solution was cooled, and volume made up to 100 ml. Then the solution prepared was filtered through filter paper (whatman no.1).

1 ml of the filtrate was taken in which 0.5 ml Folin - Denis reagent was added, then 1ml of sodium carbonate was added and volume made up to 10 ml. Then the prepared solution was left at room temperature for 30 minutes and then the absorbance was read at 760nm against a reagent blank. The tannin content in millet samples were calculated as tannic acid equivalent from the standard graph.

Determination of total oxalates

Five grams of powdered sample was taken in a 250 ml volumetric flask with 60 ml distil water, 11 ml (6N HCl) was added and boiled for 15 minutes and cooled. Volume was made up to 100 ml with distilled water. The solution was left for overnight, next day the solution was centrifuged and 25 ml supernatant was taken in which 5 ml tungstophospheric acid added, the solution left for 4hour and centrifuged. Again, the supernatant was taken in a beaker in which ammonium hydroxide was added drop wise to maintain pH of 4 - 4.5. Then 5 ml acetate buffer was added, and the solution left overnight.

The solution was centrifuged, and supernatant was discarded. The precipitate was washed with 20 ml distill water further centrifuged again discarding the supernatant. To the precipitate 5 ml

sulphric acid (1:9) was added and the solutions transferred in a conical flask with distill water. The whole solution was boiled in a water bath and titrated hot with standardized KMnO4 until the pink color persisted for 30 seconds.

Determination of total polyphenols

Phenol was determined as per Sadasivam S. and Manickam A [7].

Determination of total flavonoids

Total flavonoids were determined as per Sadasivam S. and Manickam A [7].

Determination of Reducing Sugar

Reducing sugar was determined by Nelson - Somogyl method [7].

Determination of Starch

Starch content was determined by acid hydrolysis method as per Rangana [6].

Statistical analysis

The data obtained was analyzed by Microsoft Office Excel 2007, for Analysis of Variance (ANOVA) at 5% level of significance. The data obtained from proximate analysis were subjected to one way Analysis of Variance. Similarly, t - test Two Sample Assuming Equal Variance was done for the anti - nutritional factor before and after germination.

Results

Proximate composition

The proximate analysis gives information about the nutritional and biochemical composition of foods. The proximate composition such as moisture, crude fat, crude protein, crude fibre and total ash in six Nepalese finger millet varieties were determined as per the standard procedure and results expressed in dry basis percentage.

Minerals content

Millet is a good source of minerals and comparatively had higher minerals content than other cereal out grains. Micro - nutrients such as calcium, phosphate, iron, manganese, sodium, potassium and zinc were determined. Out of these minerals potassium content in finger millet was determined to be highest. Other essential minerals like manganese, iron, zinc content was found to be appreciable amount. Calcium content in millet usually counts for about 300 - 450 mg/100. The mineral content (mg/100g) in six finger millet varieties is presented below.

Varieties	Protein	Crude fat	Crude fibre	Total ash	Moisture Starch
Dalle	7.19 (0.21)^{a}	1.37 (0.02)^{a}	2.8 (0.32)^{a}	2.2 (0.27)^{a}	14.1 (0.36) ^{a}60.12 (0.56)^{a}
GE-0116	6.805 (0.42)^{b}	1.33 (0.03)^{a}	3.33 (0.17)^{a}	2.1 (0.31)^{a}	13.6 (0.51) ^{a}59.99 (0.26)^{a}
Okhale	7.01 (0.14)^{c}	1.33 (0.05)^{a}	3.36 (0.12)^{b}	2.09 (0.26)^{a}	14.5 (0.25) ^{b}60.27 (0.58)^{a}
GE-5016	7.29 (0.15)^{d}	1.7 (0.39)a	3.12 (0.23)^{b}	2.05 (0.17)^{a}	13.4 (0.30) ^{bc}60.27 (0.26)^{a}
GPU-0025	6.8 (0.27)^{d}	1.36 (0.25)^{a}	3.5 (0.36) ^{bc}	2.09 (0.31)^{a}	13.5 (0.19) ^{bc}60.39 (0.87)^{a}
Kabre	6.82 (0.44)^{e}	1.38 (0.02)^{a}	3.09 (0.14)^{d}	1.94 (0.43)^{a}	13.8 (0.72) ^{bc}59.86 (0.36)^{a}

Table 1: Proximate composition of finger millet varieties*

*Values are the means of three determinations. Figures in the parenthesis are the standard deviation. Means followed by the same superscript in a column are not significantly different ($p > 0.05$) by LSD.

Variety	Calcium	Phosphorus	Iron	Zinc	Sodium	Potassium
GE-5016	365 (2.87)^{a}	234 (1.17)^{a}	4.44 (0.52)^{a}	2.31 (0.12)^{ab}	0.9 (0.78)^{a}	1070 (3.6)^{a}
Okhale	366 (1.4)^{a}	250 (1.3)^{a}	6.35 (0.42)^{b}	2.76 (0.17)^{b}	0.95 (0.98)^{a}	1160 (3.2)^{b}
GE-0116	354 (2.6)^{a}	248 (1.64)^{a}	4.43 (0.56)^{a}	1.83 (0.08)^{a}	0.7 (0.54)^{a}	628 (2.76)^{c}
Dalle	344.9 (1.84)^{a}	259 (2.16)^{a}	5.52 (0.35)^{c}	1.76 (0.07)^{ac}	0.65 (0.62)^{a}	750 (1.67)^{d}
GPU-0025	398 (2.76)^{a}	240 (1.48)^{a}	7.31 (0.38)^{d}	2.14 (0.16)^{b}	0.95 (0.32)^{a}	760 (1.54)^{e}
Kabre	358 (1.54)^{a}	285 (1.16)a	4 (0.14)^{a}	1.96 (0.32)^{ac}	0.85 (0.34)^{a}	834 (1.06)^{f}

Table 2: Micro - nutrient composition of finger millet (mg/100g, dry basis)*.

*Values are the means of three determinations. Figures in the parenthesis are the standard deviation.

Effect of germination in finger millet

The anti - nutritional factors present in the millet sample were determined as per the standard procedure provided. Germination of grains had a significant effect on the anti - nutritional factors. Probably the concentration of anti - nutrients decreases with germination time of the grains. The anti - nutritional and anti - oxidant profile of raw and germinated finger millet is given in the table below.

Parameters	Sample	Dalle	GPU - 0025	Kabre	Okhal	GE - 0116	GE - 5016
Tannin (mg% as tannic acid)	Raw	322.4[a] (5.21)	288.6[b] (3.13)	256.9[c] (4.21)	242.45 d (4.24)	235.4[e] (3.69)	212.4[f] (3.24)
	Germinated	394.55 g (2.51)	372.58[h] (4.07)	341.85 i (3.11)	285.65 j (4.17)	349.8[k] (4.51)	326.4[l] (3.51)
P. A.[1]	Raw	614.65 a (5.1)	526.35[b] (5.09)	570.87 c (3.17)	549.81 d (4.11)	502.8[e] (5.63)	615.2[f] (4.83)
	Germinated	181.65 g (1.31)	144.2[h] (1.94)	163.95 i (2.05)	158.86 j (2.43))	218.5[k] (2.11)	230.6[l] (3.03)
Total Oxalates	Raw	20.52[a] (1.04)	22.84[b] (2.17)	21.73[c] (1.55)	21.15[d] (1.07)	21.22[d] (2.11)	22.47[b] (2.03)
	Germinated	9.66ef (0.13)	11.68[g] (0.41)	9.87ef (0.21)	10.6[h] (0.52)	9.97[e] (0.19)	9.43[f] (1.11)
T.P.[2] (mg% as gallic acid)	Raw	362.55 a (5.21)	372.1[b] (3.52)	334.13 c (4.17)	351d (3.83)	366.4[e] (2.06)	377.8[f] (4.16)
	Germinated	157.27 g (3.12)	179.07[h] (2.48)	150.76 i (3.09)	157.27 j (3.11)	160.0[k] (2.62)	130.2[l] (2.11)
Total Flavonoids	Raw	144.45 a (1.43)	177b (1.71)	100.47 c (2.18)	99.15[d] (1.38)	93.1[e] (2.21)	100.3[c] (3.13)
Reducing sugar	Germinated	113.3[f] (0.95)	81.55[g] (2.1)	84.5[h] (1.36)	87.0i (1.78)	82.93[j] (2.1)	84.1[h] (3.01)
(mg% as dextrose)	Raw	0.96[a] (0.48)	1.51[b] (0.36)	0.97[a] (0.63)	0.76ac (0.03)	1.25ab (0.28)	1.34[b] (0.05)
_	Germinated	11.9[d] (0.91)	18.32[e] (0.08)	12.17[f] (0.71)	9.66[g] (0.31)	15.45[h] (0.91)	16.1[i] (0.09

Table 3: Anti - nutrients composition in raw and germinated finger millet*.

*Values are the means of three determinations. Means with the similar superscripts for any parameter are not significantly different ($p > 0.05$).

1Phytic acid, 2Total polyphenols.

Conclusion

On the basis of the work, the following conclusions were drawn. The average proximate composition (crude protein, moisture, crude fat, crude fibre and total ash) for all six varieties analyzed was in the range of standard value. The average protein, crude fat, crude fibre, total ash and moisture content of all six varieties were found to be 6.98%, 1.41%, 3.2%, 2.07% and13.82% on dry basis respectively. Starch content was found to be 60.13 % dry basis on an average for all six varieties. The mean value of calcium, phosphorus, iron, zinc, sodium and potassium determined was in range of 344 - 398 mg/100g, 234 - 285 mg/100g, 4 - 7.31 mg/100g, 1.7 - 2.7 mg/100g, 0.6 - 0.95 mg/100g and 628 - 1160 mg/100g dry basis respectively. Germination of finger millet seeds for 72 hours at 28 ± 2ºC had a significant effect on anti - nutritional factors of the grain. Phytic acid, total oxalates, total polyphenols and total flavonoids contents decreased by about 63.54%, 53.41%, 58.71% and 11.34% respectively after germination. While tannin content increased by about 33.21% on average for all six varieties. Finally, the reducing sugar content significantly increased by about 13 - 15 fold which gives millet a sweet taste.

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