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# Chemical and Bio-Chemical Studies on Some Hybrid Millet Seeds

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The millets are very important staple food in the rural parts of India. The three hybrid varieties of millets *viz.*, Ragi (O), Kutki (jk-8) and Kodo (jk-48) were analyzed for their proximate composition and oxalate, tannin and cyanogenetic glucosides content.

**Key Words: Composition, Oxalate, Tannin, Millets, Seeds.**

## INTRODUCTION

Cereals occupy prominent and important position in the Indian dietary. In India about one-fourth of the population is suffering from malnutrition and hence people gets deficient of many diseases. The world's protein requirement has to be met through plant proteins because of scarcity and high cost of animal proteins. Qualitative and quantitative protein deficiency prevails in the tropics where protein caloric malnutrition is of frequent occurrence. The millets supply a major part of the dietary proteins in the vegetarian diets of Indian subcontinent and African population[1]. The millets are usually rich in carbohydrates. However, their protein content is less than legumes[2]. Rural people used millets as an important staple[3] food and also an alternative for alcoholic beverages[4].

## EXPERIMENTAL

The healthy and authentic seeds under investigation were procured from Agriculture Research Station, Dindori. All the seeds were analyzed for their moisture, total ash and its analysis (acid soluble and acid insoluble ash and water soluble and water insoluble ash and alkalinity), crude fibre, total lipids, total carbohydrates, reducing sugar and non-reducing sugar phosphorus, calcium, tannin, oxalate and cyanogenetic glucosides content.

Moisture, ash (and its analysis) and calcium content were determined by the method as described by Pearson[5,6]. Crude fibre content was determined by the method recommended in the fertilizers and feeding stuffs regulation[6]. Phosphorus was determined according to the procedure of

Sumner[7]. Total lipids were determined by the method of Colowick and Kaplan[8]. Carbohydrates, reducing and non-reducing sugar were estimated by the method of Nelson[9] crude protein was estimated by micro Kjeldahl method (N × 6.25). The total oxalate in the form of oxalic acid was determined by the method of Talpatra *et al.*[10]. Tannin was determined in the seeds according to the method described in AOAC[11]. Cyanogenetic glucosides were in the seeds under the study by the method of AOAC[12]. Total energy was calculated according to the following equation:

$$\text{Energy (Kcal)} = 4 \times (\text{g protein} + \text{g carbohydrate}) + 9 \times (\text{g fat})$$

The nitrogen free extract in percent is determined by subtracting the sum of the percentages of moisture, crude protein (CP), crude fat (EE), crude fiber (CF) and ash from 100.

$$\text{Nitrogen free extract (NFE)} = 100 - (\text{moisture \%} + \text{CP \%} + \text{EE \%} + \text{CF \%} + \text{ash \%})$$

## RESULTS AND DISCUSSION

The results are shown in Tables 1-3. Since analyses are usually conducted with specially prepared samples, certain corrections must be made to the results so that they reflect the actual nutrient content of the material under the conditions in which it will be used. Therefore, if the analyses were made on a dry base, then the result must be corrected to express it on a moist base, using the formula:

$$\text{Nutrient content (\%/M.B.)}^{13,14} = A\ (100\text{-}B/100)$$

where: A: nutrient content (% D.B.), B: moisture content of material (%)

Similarly when defatted material is used a similar correction is applied to obtain a value representative of the sample, using the formula:

$$\text{Adjusted fibre content (\%)}^{13,14} = A\ (100\text{-}B/100)$$

where: A: fibre content (defatted, %), B: lipid content of the material.

TABLE-1
PROXIMATE PRINCIPLES OF AIR DRIED SEEDS OF MILLETS (g/100 g)

| Seed | Moisture | Crude fibre | Total lipid | Crude protein | Total carbohydrates | Reducing sugar | Non-reducing sugar | Energy (Kcal) | Nitrogen free extract |
|---|---|---|---|---|---|---|---|---|---|
| Ragi(O) | 12.64 | 5.62 | 1.003 | 14.69 | 96.0 | 9.6 | 86.4 | 451.787 | 62.727 |
| Kutki(jk-8) | 14.01 | 21.04 | 4.775 | 13.49 | 40.0 | 24.0 | 6.0 | 256.935 | 39.569 |
| Kodi(jk-48) | 12.49 | 14.30 | 3.061 | 17.54 | 58.6 | 10.4 | 48.2 | 332.109 | 47.640 |

TABLE-2
MINERAL AND ASH CONTENTS OF AIR DRIED SEEDS OF MILLETS (g/100 g)

| Seed | Ash | Water soluble ash | Water insoluble ash | Acid soluble ash | Acid insoluble ash | Alkalinity water soluble ash (meq $Na_2CO_3$) | Calcium | Phosphorus |
|---|---|---|---|---|---|---|---|---|
| Ragi(O) | 3.321 | 0.857 | 2.464 | 2.644 | 0.677 | – | 0.2108 | 1.595 |
| Kutki(jk-8) | 7.116 | 1.196 | 5.920 | 5.788 | 1.328 | 24.0 | 0.0496 | 1.320 |
| Kodi(jk-48) | 4.969 | 0.800 | 4.196 | 3.141 | 1.828 | 16.0 | 0.0544 | 1.100 |

TABLE-3
ANTI NUTRIENTS AND MILLETS (g/100 g)

| Seeds | Tannin | Oxalate | Cyanogenetic glucosides |
|---|---|---|---|
| Ragi (O) | 0.252 | 0.0225 | Nil |
| Kutki (jk-8) | 0.504 | 0.0262 | Nil |
| Kodo (jk-48) | 0.420 | 0.0525 | Nil |

Tables 4-6 showed the results based on moist bases and on adjusted fibre content. The study of general composition reveals that the moisture content of millets; Ragi(O), Kutki(jk-8), Kodo(jk-48) was found to be 12.64, 14.01 and 12.49 %, respectively (Table-1), which is in accordance with other varieties of millets; Ragi, Kutki, Kodo[15,16].

TABLE-4
MOIST BASES AND ADJUSTED CRUDE FIBRE CORRECTIONS OF PROXIMATE COMPOSITION OF AIR DRIED SEEDS OF MILLETS (g/100 g)

| Seeds | Crude fibre‡ | Total lipid† | Crude protein† | Total carbohydrates‡ | Reducing sugar‡ | Non-reducing sugar‡ | Cyanogenetic glucosides | Nitrogen free extracts |
|---|---|---|---|---|---|---|---|---|
| Ragi(O) | 4.85 | 0.8762 | 12.83 | 81.43 | 8.140 | 73.28 | Nil | 65.9028 |
| Kutki(jk-8) | 18.38 | 4.1060 | 11.60 | 32.75 | 19.650 | 13.10 | Nil | 45.7850 |
| Kodi(jk-48) | 12.12 | 2.6780 | 15.34 | 50.18 | 8.993 | 41.68 | Nil | 53.0240 |

†Correction based on moist bases.
‡Correction based on moist and adjusted crude fibre content.

Most of the varieties of millets; Ragi, Kutki and Kodo contains 2.1 to 3.7 %, 4.9 to 8.3 % & 2.2 to 3.7 %, respectively, of ether-extractable fat contents of air dried seeds. Total lipid content of Ragi (O) was found to be

TABLE-5
CORRECTED RESULTS BASED ON MOIST BASE FOR MINERAL AND ASH CONTENTS OF AIR DRIED SEEDS OF MILLETS (g/100 g)

| Seed | Ash | Water soluble ash | Water insoluble ash | Acid soluble ash | Acid insoluble ash | Alkalinity water soluble ash (meq $Na_2CO_3$) | Calcium | Phosphorus |
|---|---|---|---|---|---|---|---|---|
| Ragi(O) | 2.901 | 0.748 | 2.464 | 2.309 | 0.5914 | - | 0.1841 | 1.393 |
| Kutki(jk-8) | 6.119 | 1.03 | 5.09 | 4.977 | 1.1419 | 20.6 | 0.0426 | 1.135 |
| Kodi(jk-48) | 4.348 | 0.700 | 4.196 | 2.748 | 1.599 | 14.0 | 0.0476 | 0.962 |

TABLE-6
MOIST BASE CORRECTIONS FOR ANTI NUTRIENTS AND ENERGY AND NITROGEN FREE EXTRACT OF MILLETS (g/100 g)

| Seeds | Tannin | Oxalate | Cyanogenetic glucosides |
|---|---|---|---|
| Ragi (O) | 0.22 | 0.0196 | Nil |
| Kutki (jk-8) | 0.43 | 0.0225 | Nil |
| Kodo (jk-48) | 0.36 | 0.0459 | Nil |

1.003 %, which is less than (2.1 to 3.7 %) the other varieties of Ragi. Total lipid content of Kutki (jk-8) and Kodo (jk-48) was found to be 4.775 and 3.061 %, respectively which is in accordance with other varieties of Kutki and Kodo14,15 (Table-1).

After correction the lipid content of Ragi (O), Kutki (jk-8) and Kodo (jk-48) were found to be 0.8762, 4.106 and 2.678 %, respectively (Table-4).

The study of general composition reveals that the ash content of the millets *i.e.*, Ragi (O) and Kodo (jk-48) were found to be 3.321 and 4.969 % which is in agreement with other varieties of Ragi and Kodo[15,16].

The highest ash content (7.116 %) was found in Kutki which is higher than (1.8 to 5.4 %)[17] the other varieties of Kutki. However, after correction on moist bases the ash content of Kutki, Ragi and Kodo were become more significant (Table-3).

The crude protein content of ragi (O) was found to be 14.69 % which is slightly higher (5.8 to 13.0 %)[17] than other varieties of Ragi (Table-1). But after correction the crude protein content becomes 12.83 % which is in good resemblance with other varieties of Ragi. The crude protein content of Kutki (jk-8) and was found to be 13.46 % which is in accordance with the other varieties of Kutki[15]. However the crude protein content of Kodo (jk-48) was found to be 17.54 % which is higher than the other varieties of Kodo (Table-1).

The results based on moist bases for Kodo (jk-48) was found to be 15.34 % which is still non-significant with other varieties of Kodo, however the corrected results on moist bases for Ragi (O) and Kutki (jk-48) were become more significant (Table-4).

The total calcium content of Ragi (O) was found to be 0.2108 g/100 g which is less than (0.29 to 0.394 g/100 g) the other varieties of Ragi. The total calcium content of Kutki (jk-8) and Kodo (jk-48) was found to be 0.0496 g/100 g and 0.0544 g/100 g which are in agreement with other varieties of Kutki and Kodo[15] (Table-2).

After corrections the calcium content of Kutki and Kodo becomes much more relevant with other varieties of Kutki and Kodo (Table-5). However, a high value of calcium (0.2108 %) in ragi is noteworthy.

The phosphorus content in Ragi (O), Kutki (jk-8) and Kodo (jk-48) was found to be 1.595 g/100 g, 1.320 g/100 g and 1.100 g/100 g, respectively, which is very high than other varieties of Ragi, Kutki and Kodo as reported by Hulse *et al.*[15].

The carbohydrate content of Ragi (O) was found to be 96.0 g/100 g, which is higher than (70-90 %), other varieties of Ragi[15,16] (Table-1). But after correction the value was found to be 81.43 % which is in resemblance with other varieties of Ragi (Table-4).

The carbohydrate content of Kodo was found to be 58.6 g/100 g, which is slightly lesser than (60.8-68.0 g/100 g) other varieties of Kodo[15,16]. The lowest (40 %) total carbohydrates content was in variety Kutki (jk-8), which is not significant with the other varieties of Kutki (Table-1).

The major portion of carbohydrates of seeds under study was present in non-reducing form. The non-reducing sugar content was found to be highest (86.4 %) in Ragi (O) and lowest (16 %) in Kutki (jk-8) (Table-1).

Reducing sugar content of Ragi (O), Kutki (jk-8) and Kodo (jk-48) was found to be 9.6, 24.0 and 10.4 %, respectively (Table-1). The results of reducing and non-reducing sugar were reported in Table-4.

The total energy of Ragi (O) was found to be 451.787 Kcal which is higher than the value reported by Hulse *et al.*[15] (Table-1). The total energy of Kutki was found to be, 256.935 and 332.109 Kcal, respectively which is in close proximity with the values reported by Hulse *et al.*[15] (Table-3). The results of Ragi Kutki and Kodo were found to be 384.787, 214.354 and 286.182 Kcal, respectively. (Table-4).

The total tannin content of Ragi (O), Kutki (jk-8) and Kodo (jk-48) before corrections was found to be 0.252, 0.504 and 0 0.42 % (Table-3) and after corrections was ranged between 0.22 to 0.43 %, respectively. (Table-6).

Total oxalate content was highest (0.0525 %) in Kodo and lowest (0.0225 %) in Ragi (O). The results were in good proximity with other

varieties Ragi, Kutki and Kodo as was reported by Ravindran[14] (Table-3). The corrected oxalate content was ranged from 0.0196 to 0.0459 % (Table-6).

The total nitrogen free extract was high (62.727 %) in Ragi (O) and lowest (39.569 %) in Kutki (jk-8); (Table-1). The value of nitrogen free extract for Kutki (jk-8) is in good agreement with other varieties of Kutki. The values were become high after corrections (Table-4).

Table-2 represents ash and its analysis. The ash was high (7.116 %) in Kutki (jk-8) and was found lowest (3.321 %) in Ragi (O). Ragi (O) and Kodo (jk-48) was found to have almost equally water soluble ash content (0.8 %). However, Kutki (jk-8) have the highest (1.196 %) water soluble ash content (Table-2).

Acid soluble ash content of Kutki (jk-8) and Kodo (jk-48) was 5.788 and 3.141, respectively, found to be more acid soluble. (Table-2).

Alkalinity of water soluble ash was found maximum (24 %) in Kutki (jk-8) and was not detected in Ragi (O) (Table-2). The corrected results for ash and its analysis were shown in Table-5.

Cyanogenetic glucosides were not detected in Ragi (O), Kutki (jk-8) and Kodo (jk-48) (Table-3).

## REFERENCES

1. FAO, Food and Nutrition, Sorghum and Millets in Human Nutrition, Series, No. 27.
2. B. Singhal and S.K. Shrivastava, *Asian J. Chem.*, **14**, 371 (2002).
3. Rural Food Enterprises for Production Low Cost Supplementary Foods using Millets and Legumes, Terminal Report of the IDRC-Funded Project, Andhra Pradesh Agricultural University, Hyderabad, India, p. 135 (1991).
4. Department of Agronomy, College of Agricultural and Life Sciences and Cooperative Extension Service, University of Wisconsin-Madison, USA, May (1990).
5. D. Pearson, *Lab. Tech. Food Anal.*, **18**, 30 (1962).
6. D. Pearson, *Lab. Tech. Food Anal.*, **48-49**, 57 (1973).
7. J.B. Sumner, *Science*, **100**, 413 (1944).
8. S.P. Colowick and N.O. Kaplan, Methods in Enzymology-III, Academic Press Inc., New York, p. 85 (1957).
9. N.J. Nelson, *J. Biol. Chem.*, **153**, 375 (1944).
10. S.K. Talpatra, S.C. Roy and K.C. Sen, *Indian J. Vet. Sci. Anim. Husb.*, **18**, 99 (1948).
11. Association of Official Agricultural Chemists, Official Method of Analysis, Washington DC, p. 240 (1970).
12. AOAC, Official Method of Analysis, Washington DC, p. 240, 438 (1970).
13. FAO, Corporate Document Repository, Nutrition of Fish and Crustaceans-A Laboratory Manual No. 3.7.
14. G. Ravindran, *Food Chem.*, **39**, 99 (1977).
15. J.H. Hulse, E.M. Laing and O.E. Pearson, Sorghum and the Millets: Their Composition and Nutritive Value, Academic Press, New York, p. 997 (1980).
16. B.V. Babu, T. Raman and T.M. Radhakrishnan, *Indian J. Agric. Sci.*, **57**, 520 (1987).
17. M.S. Pore and N.G. Magar, *Indian J. Agric. Sci.*, **47**, 220 (1977).

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