Millets: The Indigenous Food Grains

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Abstract The present study aims to explore nutritional as well as the therapeutic potential of millets in perspectives of Ayurveda substantiated by modern scientific studies. The methodology adopted for the study includes field survey, review of literature starting from ancient Indian classics of Ayurveda, modern scientific and research-based publications including journals and periodicals. Millets are still used as supplementary food grains in tribal and relatively lesser developed parts of the country. Millets have been widely used in therapeutics in Ayurveda classics. Nutritional potential of millets may be well understood by the following facts- Pearl millet (Pennisetum typhoides Burm.f.Stapf. & Habbard) is significantly rich in resistant starch, soluble and insoluble dietary fibers, minerals and antioxidants. It contains 2.8% crude fiber, 7.8% crude fat, 13.6% crude protein, and 63.2% starch. Foxtail millet (Setaria italica Linn. Beauv.) is rich in lysine. Finger millet (Eleusine coracana Linn.) has carbohydrate 81.5%, protein 9.8%, crude fiber 4.3% and minerals 2.7% which is higher than wheat and rice. Kodo millet (Paspalum scrobiculatum Linn.) and little millet (Panicum miliale Lam.) also have 37.38% dietary fiber which is highest among cereals. In Proso millet (Panicum miliaceum Linn.) protein content found to be 11.6% of dry matter and is greater than wheat protein. Millets have a high nutritive value comparable to major cereal grains. Thus millet proteins are a good source of essential amino acids, micronutrients, phytochemicals, antioxidants, and minerals. The presence of all required nutrients in millets makes them potential dietary supplements.

Keywords Antioxidants; Dietary supplement; Essential amino acids; Millets

1. Introduction

Millets are oldest as well as primitive indigenous food grains to be used as staple food. The word “Millet” derived from the latin word “Milium” means small seed (Robert, 2000). Millets are a specific group of plant of Poaceae family containing smaller seed than major cereals (Macdonell and Keith, 1958). They are unique among food grains having smaller size but higher in nutrition. They were first ever introduced in Rigveda then in Yajurveda and Atharvaveda (Bindu, 2010). In Ayurvedic text millets have been referred by the name as Kudhanya (Shastri, 2011) and Trin Dhanya (Gupta, 2011). These are Sama (Echinochloa frumentace Linn.), Kodo (Paspalum scrobiculatum Linn.), Neewar (Hygroryza aristata Retz.), Gavedhuk (Coix lacryma jobi Linn), Kanguni (Setaria italica Linn. Beauv.), Cheena (Panicum miliacum Linn.), Jowar (Sorghum vulgare Pers.), Ragi (Eleusine coracana Linn.), Bajra (Pennisetum typhoides Burm.f.Stapf. & Habbard). Millets have been used as food as well as therapeutic diet in Ayurveda since samhita kala. The one of the best therapeutic indication of these grains is as Pathya in various diseases.
1.1. Objective of the Study

The present study aims to explore the nutritional as well as therapeutic potential of millets and advocate their use as future staple food grains for developing countries.

Table 1: Therapeutic indication of millets in Ayurvedic

| Millet          | Botanical Name                     | Synonyms                         | Rasa | Guna   | Therapeutic uses                              |
|-----------------|------------------------------------|----------------------------------|------|--------|-----------------------------------------------|
| Sama (Barnyard Millet) | Echinochloa frumentace Linn.       | Shayamak, Shyam, Tribeej, Rajdhanya, Trinbeej, Uttam (Shastri, 2011) | M, S | Sheet, Snigdh, Laghu | Obesity, Raktapitta, Pittaj kasa, Urustamba, Stanyodasa, Jalodara |
| Kodo Millet     | Paspalum scrobiculatum Linn.       | Kodrav, Kordush, Kudyal, Uddalak, Madanagraj | M, T | Guru, Rukha | Obesity, Raktapitta, Pittaj kasa, Visha, Urustamba, Trishna, Jalodara, Kusta Stanyodasa, Jalodara |
| Gavedhuk (Job’s Tear) | Coix lacryma jobi Linn.            | Vaiyanti                          | K, M | Rukha | Obesity, Kapaj Chardi                          |
| Kanguni (foxtail Millet) | Setaria italica Linn. Beav. | Kanguni, Pitatandula, Vatal, Sukumar, Priyangu | M, S | Guru, Rukha | Kusta Vatakarak, Pittadaha nashak, Bhagna-asthi Sandhan |
| Cheena (Common Millet) | Panicum miliaceum Linn. | Varak, Sthulukangu, Sthul priyangu, Kangubhed, Marha | M, S | Rukha | Brihana                                        |
| Jwar (Great Millet) | Sorghum vulgare pers. | Jumahwa,Yavnal, Raktika Krostupucca, Sugandhika, | M     | Guru, Sheet | Brihana Malrodhak, Ruchikarak, Vryavadhak, Raktavikar |
| Ragi (Finger Millet) | Eleusine coracana Linn. | Madhuli, Ragika, Nartak, Madua   | M, T, S | Laghu sheet | Brihana Triptikarak, Balakarak, Raktapitta shamak |
| Bajra (pearl Millet) | Pennisetum typhoides Burm.f.Stapf. & Habbard | Bajranna, Sajak, Nalika, Neelkaran, Agrayadhanya | M     | Ruksh, Ushna | Balya, Agnideepak, Strikamodpadaka, Punsatvahar, Durjara (nighantu ratnakar) |
| Neewar | Hygroryza aristata Nees. | Tini, Aranyadhanya, Munidhanya, Trinodbhav | M     | Laghu, Snigdh, Sheet | Raktapitta, Vatarakta, Pathya, Kaphkarak, Malamutra rodhak |

2. Methodology

The methodology adopted for the study includes field survey, literary survey including Ayurvedic literature and research papers related to the topic.

2.1. Nutritive Value of Millets

Nutritional value is the key feature of dietary quality and potential aspect of food grains, because nutrition is responsible for complete physical well being of the society. The richness in dietary fiber, protein, calcium, iron, potassium, zinc, magnesium, vitamins, makes them unique among the cereals. Millets are gluten free, so least allergenic and most digestible grains.
The table shows all the nutritional aspects of millets with respect to major cereals (Ravindran, 1991).

| Plant Name                      | Scientific Name                  | Description                  |
|---------------------------------|----------------------------------|------------------------------|
| Echinochloa frumentacea         | Linn. (Sanwa)                    |                             |
| Paspalum scrobiculatum          | Linn. (Kodo)                     |                             |
| Coix lacryma jobi Linn.         | (Gavedhuka)                      |                             |
| Setaria italica Linn. Kanguni   |                                  |                             |
| Panicum miliaceum Linn. Cheena   |                                  |                             |
| Sorghum vulgare pers. Jwara     |                                  |                             |
| Eleusine coracana Linn. Ragi (Madua) |                       |                             |
| Pennisetum typhoides           | Burm.f.Stapf. & Habbard (Neewar) |                             |
| Hygroryza aristata Nees. (Bajara)|                                  |                             |

### 3. Results and Discussion

Pearl millets is significantly rich in resistant starch, soluble and insoluble dietary fibers, minerals and antioxidants. It contains about 92.5% dry matter, 2.1% ash, 2.8% crude fiber, 7.8% crude fat, 13.6% crude protein and 63.2% starch.

Foxtail millet is used as a supplementary protein source as it is rich in lysine. Finger millet has a carbohydrate content of 81.5%, protein 9.8%, crude fiber 4.3%, and mineral 2.7% that is comparable to other cereals and millets. Its crude fiber and mineral contents are markedly higher than that of wheat (1.2% fiber, 1.5% minerals) and rice (0.2% fiber, 0.6% minerals).

The protein content is relatively better balanced and contains more lysine, threonine, and valine than other millets. Kodo millet and little millet were also reported to have 37% to 38% of dietary fiber, which is the highest among the cereals and has higher polyunsaturated fatty acids. The protein content of Proso millet (11.6% of dry matter) is significantly rich in essential amino acids (leucine, isoleucine, and methionine) than wheat protein. Pearl millet has highest content of micronutrient as iron, zinc, magnesium, phosphorus and vitamins as folic acid and riboflavin. Finger millet is excellent source of calcium and PUFA (Poly unsaturated fatty acids). Barnyard millet contains highest protein.
content next to Foxtail millet. All the essential elements of the diet which are responsible for the development of human being are present in millets.

### Table 2: Nutrient composition of millets compared to major cereals (per 100 g)

| Food grains    | Carbohydrate (g) | Protein (g) | Fat (g) | Energy (kcal) | Fiber (g) | Mineral (mg) | Ca (mg) | P (mg) | Fe (mg) |
|----------------|------------------|-------------|---------|---------------|-----------|--------------|---------|--------|---------|
| Finger millet  | 72.0             | 7.3         | 1.3     | 328           | 3.6       | 2.7          | 344     | 283    | 3.9     |
| Kodo millet    | 65.9             | 8.3         | 1.4     | 309           | 9.0       | 2.6          | 27      | 188    | 0.5     |
| Proso millet   | 70.4             | 12.5        | 1.1     | 341           | 2.2       | 1.9          | 14      | 206    | 0.8     |
| Foxtail millet | 60.9             | 12.3        | 4.3     | 331           | 8.0       | 3.3          | 31      | 290    | 2.8     |
| Little millet  | 67.0             | 7.7         | 4.7     | 341           | 7.6       | 1.5          | 17      | 220    | 9.3     |
| Barnyard millet| 65.5             | 6.2         | 2.2     | 307           | 9.8       | 4.4          | 20      | 280    | 5.0     |
| Sorghum        | 72.6             | 10.4        | 1.9     | 349           | 1.6       | 1.6          | 25      | 222    | 4.1     |
| Bajra          | 67.5             | 11.6        | 5.0     | 361           | 1.2       | 2.3          | 42      | 296    | 8.0     |
| Wheat          | 71.2             | 11.8        | 1.5     | 346           | 1.2       | 1.5          | 41      | 306    | 5.3     |
| Rice           | 78.2             | 6.8         | 0.5     | 345           | 0.2       | 0.6          | 10      | 160    | 0.7     |

Source: Nutritive value of Indian foods, NIN, 2007

### Table 3: Essential amino acid profile of Millets (mg/g of N)

| Grains         | Agn | Htd | Lyn | Typ | PhA | Tyn | Mth | Cyn | Thy | Luc | Ile | Vln |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Foxtail        | 220 | 130 | 140 | 60  | 420 | -   | 180 | 190 | 100 | 100 | 140 | 90  |
| Proso          | 290 | 110 | 190 | 50  | 310 | -   | 180 | 190 | 100 | 110 | 140 | 90  |
| Finger         | 300 | 130 | 220 | 100 | 310 | 220 | 210 | 140 | 240 | 210 | 140 | 90  |
| Little         | 250 | 120 | 110 | 60  | 330 | -   | 180 | 90  | 190 | 370 | 300 | 320 |
| Barnyard       | 270 | 120 | 150 | 50  | 430 | -   | 180 | 110 | 200 | 650 | 370 | 350 |
| Sorghum        | 240 | 160 | 150 | 70  | 300 | 180 | 100 | 90  | 210 | 880 | 270 | 340 |
| Bajra          | 300 | 140 | 190 | 110 | 290 | 290 | 150 | 90  | 230 | 500 | 300 | 380 |
| Rice           | 480 | 130 | 230 | 80  | 280 | 290 | 150 | 90  | 230 | 500 | 300 | 380 |

Source: Nutritive value of Indian foods, NIN, 2007

Agn-Argenine, Htd-Histidine, Lyn-Lysine, Typ-Tryptophan, PhA-Phenylalanine, Tyn-Tyrosine, Mth-Methionine, Cyn-Cytosine, Thy-Thyrosine, Luc-Lucine, Ile-Isolucine, Vln-Valine

### Table 4: Fatty acid composition of millets

| Millet      | Palmitic | Palmoelic | Stearic | Oleic | Linoleic | Linolenic |
|-------------|----------|-----------|---------|-------|----------|-----------|
| Foxtail     | 6.40     | -         | 6.30    | 13.0  | 66.50    | -         |
| Proso       | -        | 10.80     | -       | 53.80 | 34.90    | -         |
| Finger      | -        | -         | -       | -     | -        | -         |
| Little      | -        | -         | -       | -     | -        | -         |
| Sorghum     | 14.0     | -         | 2.10    | 31.0  | 49.0     | 2.70      |
| Bajra       | 20.85    | -         | 1.90    | 42.50 | 39.10    | 1.10      |
| Rice        | 15.0     | -         | 1.90    | 42.50 | 39.10    | 1.10      |
| Wheat       | 24.50    | 0.80      | 1.00    | 11.50 | 56.30    | 3.70      |

Source: Nutritive value of Indian foods, NIN, 2007

In Ayurvedic texts all the millets are specially indicated as Pathya in many diseased conditions since primitive time. C. lacryma has been said to be best for losing fat and obesity. P. scrobiculatum and E. frumentace used for Obesity, Ratakittta, Pittaja Kasa, Visha, Urustambha, Trishna, Kustha, Stanyakosa, Jalodara. E. coracana used for Brihana Triptikarak, Balay, Ratakittta shamak. P. typhoides used for Balya, Agnidepak, Strikamopadaka.
Table 5: Amylose and amylopectin content of millets

| Food grain   | Amylose (%) | Amylopectin (%) |
|--------------|-------------|-----------------|
| Proso millet | 28.2        | 71.8            |
| Foxtail millet | 17.5        | 82.5            |
| Kodo millet  | 24.0        | 76.0            |
| Finger millet | 16.0        | 84.0            |
| Sorghum      | 24.0        | 76.0            |
| Bajra        | 21.1        | 78.9            |
| Rice         | 12.19       | 88.81           |
| Wheat        | 25.0        | 75.0            |

Source: MILLET in your Meals, Available from: http://www.sahajasamrudha.org

Table 6: Micronutrient profile of Millets (mg/100g)

| Millets    | Mg  | Na  | K   | Cu  | Mn  | Mb  | Zn  | Cr  | Su  | Cl  |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Foxtail    | 81  | 4.6 | 250 | 1.40| 0.60| 0.070| 2.4 | 0.030| 171 | 37  |
| Proso      | 153 | 8.2 | 113 | 1.60| 0.60| -    | 1.4 | 0.020| 157 | 19  |
| Finger     | 137 | 11.0| 408 | 0.47| 5.49| 0.102| 2.3 | 0.028| 160 | 44  |
| Little     | 133 | 8.1 | 129 | 1.00| 0.68| 0.016| 3.7 | 0.180| 149 | 13  |
| Barnyard   | 82  | -   | 0.60| 0.96| -   | 3    | 0.090| -   | -   |
| Kodo       | 147 | 4.6 | 144 | 1.60| 1.10| -    | 0.7 | 0.020| 136 | 11  |
| Sorghum    | 171 | 7.3 | 131 | 0.46| 0.78| 0.039| 1.6 | 0.008| 54  | 44  |
| Bajra      | 137 | 10.9| 307 | 1.06| 1.15| 0.069| 3.1 | 0.023| 147 | 39  |
| Rice       | 90  | -   | 0.14| 0.59| 0.058| 1.4 | 0.004| -   | -   |
| Wheat      | 138 | 17.1| 284 | 0.68| 2.29| 0.051| 2.7 | 0.012| 128 | 47  |

Source: Nutritive value of Indian foods, NIN, 2007

Table 7: Vitamin profile of Millets (mg/100g)

| Millet     | Vit.B₁ | Vit.B₂ | Vit.B₃ | Vit.A | Vit.B₆ | Folic Acid | Vit.B₅ | Vit.E |
|------------|--------|--------|--------|-------|--------|------------|--------|-------|
| Foxtail    | 0.59   | 3.2    | 0.11   | 32    | -      | 15.0       | 0.82   | 31.0  |
| Proso      | 0.41   | 4.5    | 0.28   | 0     | -      | -          | 1.2    | -     |
| Finger     | 0.42   | 1.1    | 0.19   | 42    | -      | -          | 18.3   | -     |
| Little     | 0.3    | 3.2    | 0.09   | 0     | -      | -          | 9.0    | -     |
| Barnyard   | 0.33   | 4.2    | 0.1    | 0     | -      | -          | -      | -     |
| Kodo       | 0.15   | 2.0    | 0.09   | 0     | -      | 23.1       | -      | -     |
| Sorghum    | 0.38   | 4.3    | 0.15   | 47    | 0.21   | 20.0       | 1.25   | 12.0  |
| Bajra      | 0.38   | 2.8    | 0.21   | 132   | -      | 45.5       | 1.09   | 19.0  |
| Rice       | 0.41   | 4.3    | 0.04   | 0     | -      | 8.0        | -      | -     |
| Wheat      | 0.41   | 5.1    | 0.1    | 64    | 0.57   | 36.8       | -      | -     |

Source: Nutritive value of Indian foods, NIN, 2007

4. Conclusion

Ayurvedic literature reflects that millets (minor grains) have been used as a dietary supplement as well as a therapeutic agent for long time. Overall nutritional superiority of millets equips them with nutritional and neutraceutical potential. These grains are ignored by society because of inclination towards rice and wheat. Our society is suffering from malnutrition and other dietary insufficiencies. So, we have to change the food habits. It is the only way to conserve the indigenous food grains of India.
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