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# Proximate Assessment and Pasting Properties of Gluten-Free and Refined Wheat Flour

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The present study focused on the nutritional evaluation and pasting properties of gluten-free and refined wheat flour. Gluten-free kodo and kutki flour and refined wheat flour were used as raw materials for the experiment. Nutritional content was estimated using an Association of Official Analytical Chemists (AOAC) approved method of analysis. The pasting properties of flour samples were determined with a Rapid Visco Analyzer (RVA). Results of the nutritional analysis of gluten-free flours indicated higher mineral content in kodo, followed by kutki and refined wheat flour, while ash content was highest for kodo flour and lowest for wheat flour among the investigated flours. The higher amount of protein, minerals, biomolecule components, and high fiber content in millet flour makes it a good alternative among other flours to develop millet-fortified, healthier food products. The higher peak viscosity observed for kutki compared to kodo and wheat flour may be

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due to the lower protein content and higher ash content present in kodo flour. The final viscosities ranged from 2186 to 6453 cP, with the highest for kutki flour, followed by kodo and refined wheat flour. FV increases significantly with an increase in protein and fat content. The greater breakdown viscosity was found for kutki flour, followed by kodo and refined wheat flour, indicating that kutki flour has a low ability to withstand shear stress and heat. Lower setback values indicate a low rate of starch retro gradation and synerisis in refined wheat flour. The greater pasting temperature was shown by kutki flour, depicting the higher energy and time required for cooking and correlating with higher amylose content.

*Keywords: Proximate; pasting properties; millet flours; gluten free; refined wheat flour.*

## 1. INTRODUCTION

Millet plays an important role in serving underprivileged groups in Africa, East Asia, and the Indian subcontinent. Millet became a part of the human diet about 10,000 years ago, even before the rise of wheat and rice [1].

Kodo and Kutki millet are containing a higher proportion of dietary fiber [2]. They are easy to digest and contain an adequate amount of B vitamins, especially niacin, B6, and folic acid, as well as the minerals calcium, iron, potassium, magnesium, and zinc. In view of its good nutritional properties, it is also termed nutri-cereal'. Due to their vast use by economically weaker population segments in Asian and African countries, they are often referred to as coarse grain cereals and the poor man's crop.

Millets were manually cleaned by washing in clean water using local calabash, decanting by sedimentation, draining, and drying in a cabinet dryer at 50 $^{o}$C for 6 hours. The resulted dried millets were milled into flour using a hammer mill (2014 Hot Model PC 120) and sieved to pass through a 0.2mm mesh [3].

The viscosity changes produced by heating and cooling starch in water generally provide a characteristic pasting curve. The pasting properties showed varied trends in peak, trough, breakdown, final, and setback viscosities, pasting time, and temperature. The evaluation of paste property indicates the most appropriate application of flour (9) [1]. This property depends on the molecular structure of starch and the components contained in flour (10) [4]. The objective of this study was therefore to determine the nutritional composition and pasting properties of gluten-free kodo, kutki, and refined wheat flour.

## 2. MATERIALS AND METHODS

Refined wheat flour, Kodo millet flour, and Kutki millet flour were used as raw materials for the experiment. These were procured from the local markets of Mandala and Dindori districts, and wheat from Jabalpur market. Kodo and kutki millet were cleaned and graded in the Perfura de-stoner, grader, and aspirator, and milled by the Perfura milling machine. The preparation of flour from milled millet and wheat grain was done by a domestic grinding flour mill in the cereal technology lab, department of food science and technology.

### 2.1 Analytical Method

#### 2.1.1 Estimation of Protein Content

Crude Protein present in gluten-free flours was estimated using micro Kjeldahl method, [5] with KELPLUS nitrogen estimation system. The Kjeldahl method can conveniently be divided into three steps: digestion, distillation or neutralization and titration. 0.1g to 0.3 g of ground flour samples was taken in a digestion tube and digested. After digestion, contents were cooled and distillated in KjelPlus distillation unit. After completion of distillation, the boric solution is titrated for estimation of nitrogen content. Once the nitrogen content has been determined, protein content is obtained by multiplying the total nitrogen content by a factor of 6.25.

$$N\ (\%) = \text{Normality of } H_2SO_4 \times \text{Volume of } 0.1N\ H_2SO_4 \times 0.014 / \text{Weight of the sample} \times 100$$

$$\text{Protein } (\%) = \text{Nitrogen } (\%) \times 6.25$$

#### 2.1.2 Determination of fat content

The oil content of the sample was determined by the procedure as described in [6] 5 gm. of grinded sample was weighed accurately, placed in thimble and plugged with cotton. The extractor-containing thimble was placed over a pre weighed extraction flask (A). Oil content was determined by extracting the sample with solvent petroleum ether (AR grade 60-80°C) for 4 hr.

using soxhlets extraction procedure. After extraction the excess of solvent was distilled off and the residual solvent was removed by heating at 80ºC in oven for 4-6 hours. The oil content was determined as below:

Crude fat (%) = Weight of flask (B)-Weight of flask (A) / Weight of sample (W) X100

Where,

B= Weight of empty oil flask (gm.)
A= Weight of flask with oil (gm.)
W = initial weight of sample (gm.)

### 2.1.3 Estimation of Ash content

Ash in the sample was estimated by employing the standard method of analysis [5]. Five gram of dried sample were taken in a weighed crucible and ignited on a gas stove until no charred particles remained in the crucible. After that, place the crucible in the muffle furnace and heat to 550 oC for 2 $^{1/2}$ hours. Thereafter, remove the crucible from the furnace carefully, cool it in a desiccator to room temperature, and take the final weight. Ash content is then calculated by knowing the difference in weight.

$$\text{Ash Content} = \frac{W_2 - W_1}{W} \times 100$$

Where,

$W_1$ = Weight of empty crucible (gm.)
$W_2$ = Weight of crucible and ash (gm.)
W = initial weight of sample (gm.)

### 2.1.4 Determination of fiber content

The fibre was determined by the method as described in AOAC (2019).

### 2.1.5 Reagents

1. Sulphuric acid 0.255 N
2. Sodium hydroxide 0.313N

## 2.2 Procedure

2 gm. of dry defatted sample was transferred into 500ml conical flask to which 200ml of 0.255 N boiling sulphuric acids was added then it was boiled for 30 minutes, kept the volume constant by the addition of water at frequent intervals. The mixture was cooled and filtered through a muslin cloth and the residue was washed with hot water till free from acid. The material was then transferred to the same beaker and 200ml of boiling 0.313N NaOH was added. After boiling for 30 minutes the mixture was cooled and again filtered through muslin cloth. The residue was washed with water till it get free from alkali, followed by washing with absolute alcohol and ether to remove the moisture and residue fat. It was then transferred to a weighed crucible and kept in oven at 100oC for 4-6 hours. The crucible was cooled and weighed. The difference in weight represents the crude fibre content.

$$\text{Fiber content (\%)} = \frac{W_1 - W_2}{W} \times 100$$

Where,

W1 = Weight after oven drying (gm)
W2 = Weight after ashing (gm)
W = initial weight of sample (gm)

### 2.2.1 Determination of moisture content

The moisture content in the sample was estimated according to the method of [6]. The sample (5g) was taken in pre-weighed moisture box, dried at 105 ºC for 24hr in hot air oven, cooled in desiccators again weighed. The difference in weight of moisture box represents the moisture content of the sample.

Moisture (%) = Difference in the weight / Weight of the sample X 100

**Table 1. Pasting properties of gluten-free flours and refined wheat flour**

| Std. Run. | Run | Peak value (PV) | Trough (TV) | Breakdown (BD) | Final Visc.(FV) | Setback (SB) | Peak Time (PT) | Pasting Temp. (GT) |
|---|---|---|---|---|---|---|---|---|
| 1 | Kodo flour | 2363 | 1559 | 804 | 4773 | 3214 | 5.13 | 83.95 |
| 2 | Kutki Flour | 3130 | 1801 | 1329 | 6453 | 4652 | 5.27 | 81.40 |
| 3 | Refine WF | 1898 | 1382 | 516 | 2186 | 804 | 6.20 | 69.35 |

### 2.2.2 Determination of Pasting Properties

The pasting properties of flour samples were determined with a Rapid Visco Analyzer RVA (RVA, Perten Instruments, Huddinge, Sweden) interfaced with a computer equipped with Thermo Cline Software (TCW). The Rapid Visco Analyzer RVA has been widely used and is well known for assessing the pasting properties of flour or starch. Ground flour samples (3.0 g) for moisture content of 12% w.b. were added to 25 ml of distilled water and mixed in an RVA canister. The pasting profiles were measured by using standard profile 1. The sample was heated to 50°C and held for 1 min, then increased to 95°C and held for 1.5 min, before being cooled to 50°C and held for 2 min. The paddle speed was 960 rpm for the first 7 s (homogenization of the sample) and then 160 rpm. A standard profile is completed in 13 minutes or less (Deffenbaugh and Walker 1989). Parameters recorded were peak viscosity (PV), trough viscosity (TV = Peak Breakdown), breakdown (BD), final viscosity (FV), setback (SB=FV-TV), peak time (PT), and pasting temperature (GT) [7-10].

## 3. RESULTS AND DISCUSSION

Results of nutritional analysis of gluten-free flours and refined wheat flour (Table 2) indicated higher protein content in RWF (12.21%) followed by kodo flour (8.16) and kutki flour (7.84) while ash content varied from 1.47 to 2.41 with highest for kodo flour and lowest for wheat flour among the investigated flours. High ash content in kodo flour is an indication of higher amount of minerals present in the kodo.

Peak viscosity (PV) is an indicator of water binding capacity and ease with which the starch granules are disintegrated and often correlated with final product quality (11). The peak viscosities varied from 898 to3130 cP with kutki flour has higher peak viscosity followed by kodo flour and lowest for wheat flour, indicating kutki flour has higher water binding capacity resulting in more swelling of starch granules. Higher peak viscosity observed for kutki compared to kodo and wheat flour may be due to lower protein content present in kutki flour (4).

Peak time to achieve FV varied from 5.13 to 6.20 minutes and was higher for kutki flour and low for kodo and wheat flour. Peak time decreases with an increase in pasting temperature. The pasting characteristics of gluten-free flours and refined wheat flour measured using a Rapid Visco Analyzer RVA is depicted in Figs. 1, 2, and 3.

| Test results 1- Kodo flour | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test** | **Peak 1** | **Trough 1** | **Breakdown** | **Final Visc** | **Setback** | **Peak Time** | **Pasting Temp** |
| 01 | 2363.00 | 1559.00 | 804.00 | 4773.00 | 3214.00 | 5.13 | 83.95 |

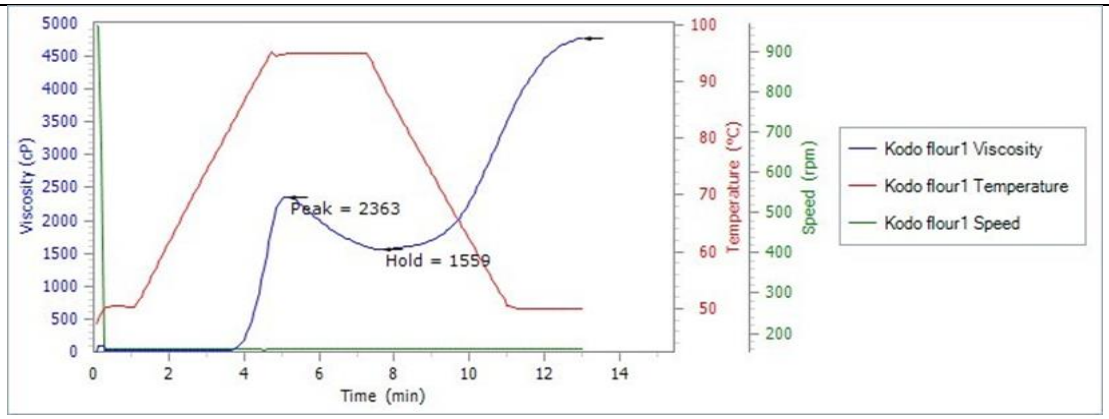


**Fig. 1. Viscosity profile of kodo flour**

**Table 2. proximate properties of gluten-free flours and refined wheat flour**

| S.N. | Grain | Moisture (%) | Protein (%) | Carbohydrate (%) | Fat/Oil (%) | Crude fiber(%) | Ash.(%) |
|---|---|---|---|---|---|---|---|
| 1 | Kodo | 10.55 | 8.16 | 67.03 | 1.74 | 10.11 | 2.41 |
| 2 | Kutki | 9.87 | 7.84 | 69.35 | 3.84 | 7.32 | 1.78 |
| 3 | Wheat | 11.08 | 12.21 | 72.21 | 1.62 | 1.41 | 1.47 |

| Test results 1- Kutki flour | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test** | **Peak 1** | **Trough 1** | **Breakdown** | **Final Visc** | **Setback** | **Peak Time** | **Pasting Temp** |
| 02 | 3130.00 | 1801.00 | 1329.00 | 4653.00 | 4652.00 | 5.27 | 81.40 |

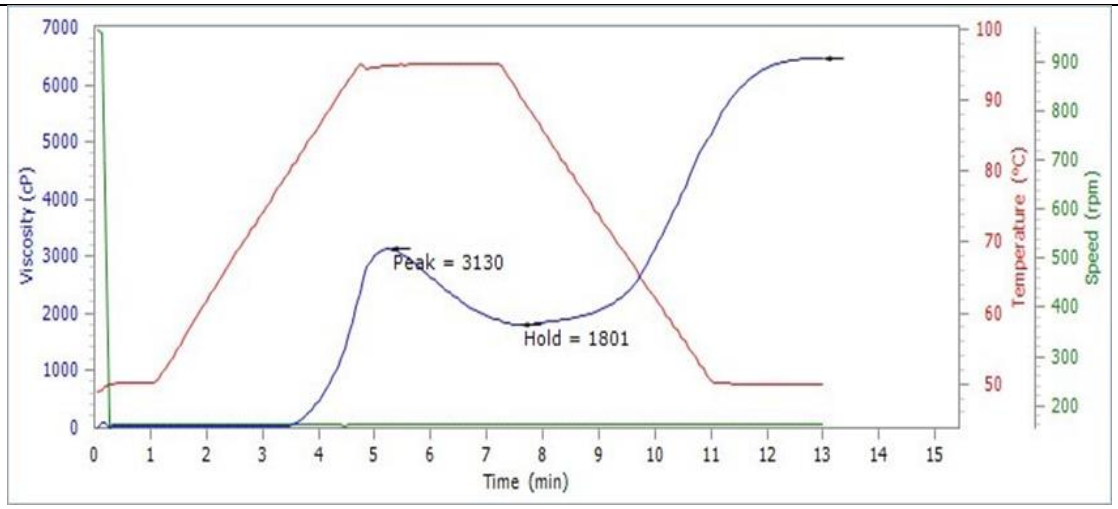


**Fig. 2. Viscosity profile of kutki flour**

| Test results 1- Refined wheat flour | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test** | **Peak 1** | **Trough 1** | **Breakdown** | **Final Visc** | **Setback** | **Peak Time** | **Pasting Temp** |
| 02 | 1898.00 | 1382.00 | 516.00 | 2186.00 | 804.00 | 6.20 | 69.35 |

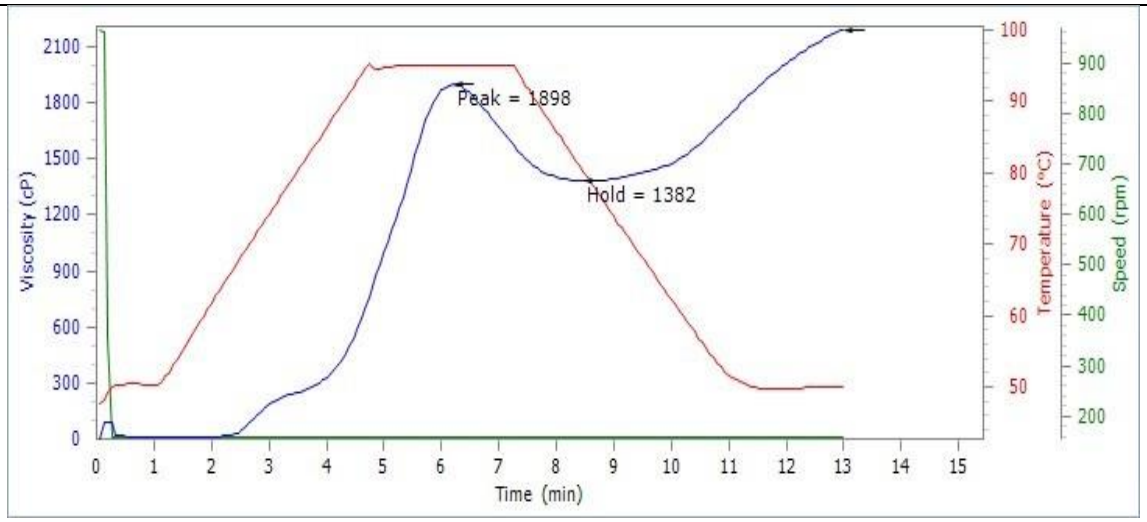


**Fig. 3. Viscosity profile of refined wheat flour**

## 4. CONCLUSIONS

The use of gluten-free flours and refined wheat flour in the preparation of composite flour is a big challenge for research and development in the millet-fortified food processing operation. The viscosity changes produced by heating and cooling starch in water generally provide a characteristic pasting curve, which gives mentionable differences in the pasting properties of the investigated flours. The measurement of viscosity in heating-cooling cycles can provide many useful indicators for the quality assessment of final products and raw materials. The nutritional value of the investigated flours has a remarkable effect on the pasting properties of the flours.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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