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Study of Parboiling Technique of Sorghum

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Abstract:- Parboiling of sorghum is the process carried out by partial boiling of sorghum after soaking it for 2 to 4 hours for increasing its hardness and nutritional quality. Maldandi (M-35-1) variety of sorghum was left to soak, highly steamed at 60^0C, 70^0C and 80^0C, dried and then milled. The physical and nutritional properties of sorghum grains were determined. The parboiling of sorghum was to be found effective in terms of increase in its milling and nutritional quality. The best parboiling technique proved for increase in quality of sorghum grains was soaking of grains at 80^0C for 4 hours, then steaming for 20 minute and cabinet drying until moisture of grains reaches to the 12% dry basis.

Keywords:- *Parboiling, Sorghum, Milling Quality, Nutritional Quality.*

I. INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major cereal crop consumed in India after paddy and wheat. It is considered as coarse grain due to presence of outer fibrous bran of seed. It has recently gained more attention as a human food source due to its gluten-free nature and high content of health-promoting components, such as antioxidant phenolic compounds. Usually Sorghum has 349 kcal energy, 9.6% protein, 3.8% fat, 73.2% carbohydrates, 2.4% ash and 11% moisture content. While sorghum has traditionally been utilized as livestock feed and for biofuel production in developed countries, there is growing interest in its consumption, especially in semi-arid and arid regions, where its adaptability to drought and high temperatures makes it a significant part of the diet. However, there is a lack of information on the optimal parboiling conditions for producing flours from sorghum, particularly from different sorghum hybrids. The potential applications of sorghum flours in various food products are extensive, including cookies, cakes, pasta, snacks, and more. The most common industrial milling process for obtaining sorghum pre-gelatinized flours involves decortications followed by hammer milling.

Parboiling, a hydrothermal pre-milling treatment, is often used to gelatinize starch in grains like rice, leading to physical, chemical, and organoleptic changes that affect milling, storage, cooking, and eating qualities. Despite its potential benefits, there is limited research on the parboiling of sorghum grains, especially red sorghum hybrids, and its impact on flour quality. The optimization of this process could contribute to making sorghum-based flours economically feasible and enhance their nutritional quality for various food applications. In view of this, the experiment was conducted with the objectives to study the effect of parboiling on milling quality of sorghum grains and to compare the quality of parboiled sorghum grains with original grains in terms of its physical and nutritional properties.

II. MATERIALS AND METHODS

Sorghum of variety ‘Maldandi (M35-1) was used as a raw material for the experimentation and effect of parboiling on milling quality of sorghum grain was examined as per the flow chart given in Fig. 1.

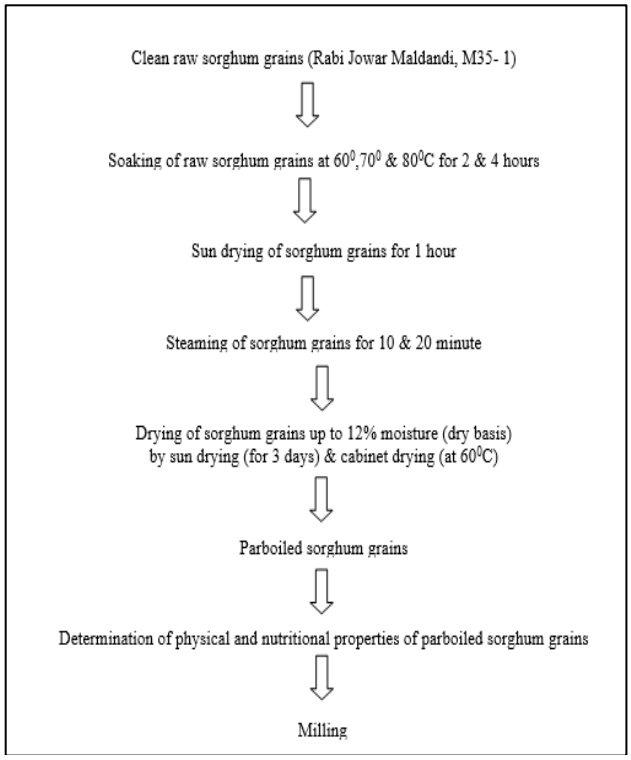

Fig 1: Flow Chart for Parboiling of Sorghum Grains

➢ *For Each of Hot Water Soaking Temperatures of 60^0,70^0 and 80^0C, the Details of Treatments Were*

- T1: 2 hours soaking + 10 minute steaming + sun drying
- T2: 2 hours soaking + 10 minute steaming + cabinet drying
- T3: 2 hours soaking + 20 minute steaming + sun drying
- T4: 2 hours soaking + 20 minute steaming + cabinet drying

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- T5: 4 hours soaking + 10 minute steaming + sun drying
- T6: 4 hours soaking + 10 minute steaming + Cabinet drying
- T7: 4 hours soaking + 20 minute steaming + Sun drying
- T8: 4 hours soaking + 20 minute steaming + Cabinet drying

➢ *Determination of Physical Properties*

Determination of physical properties namely sphericity & hardness of parboiled and un-parboiled sorghum grains were estimated by using procedure stated below.

- *Sphericity*

It is the ratio of surface area of sphere having same volume as that of the particle to the surface area of particle. Length was measured at 3 axis of the grains the largest length is taken as the value *a*, length normal to *a* is taken as *b*, and the smallest length is taken as the *c*.The readings largest and smallest circles were taken by vernier calliper and the sphericity was calculated by using equation (1) (Chakraverty, 1995) .

$$\text{Sphericity} = \frac{(abc)1/3}{a} \quad (1)$$

Where,
a = Diameter of largest inscribed circle, mm,
b = Diameter normal to a, mm,
c = Diameter smaller than a & b, mm

- *Hardness*

Hardness was tested by Hardness Tester (Monsanto Type). Sample grain was placed in hardness tester and the knob was tighten till breaking of grain sample and at that point the reading on the instrument was taken in kg/cm^2

➢ *Determination of Nutritional Properties*

Determination of nutritional properties namely moisture (%db), carbohydrate, protein, fat & ash content of parboiled and un-parboiled sorghum grain were estimated by using standard procedure stated in AOAC (2000).

➢ *Determination of Milling Characteristics*

To determine the milling characteristics of parboiled and un-parboiled sorghum grains, its milling percentage and milling loss were calculated. For that, 100 gm of milled sorghum grains (flour) was passed through IS100 sieve and the left over the sieve after straining was weighed and milling percentage was calculated by equation (2).

$$\text{Milling Percentage} = \frac{\text{weight of flour obtained after sieving}}{\text{weight of flour}} \text{ X } 100 \quad (2)$$

III. RESULTS AND DISCUSSION

A. *Sphericity of Sorghum Sample*

From Fig. 2, it can be seen that the average sphericity of un-parboiled grains was found to be the 79%. Highest minimum sphericity of 88% was found at 4 hours soaking, 20 minute steaming & cabinet drying of sorghum sample for all the three soaking water temperatures of 60^{0}C, 70^{0}C and 80^{0}C. Sphericity was observed to be increased with increase in soaking and steaming time in both the types of drying methods. This may be due to the increase in size of sorghum grains because of holding of more moisture at its elongated soaking and steaming time.

B. *Hardness of sorghum sample*

From Fig. 3, it can be observed that the average hardness of un-parboiled sorghum grains was found to be 3.81Kg/cm^2. The highest hardness of 4.70 Kg/cm^2 was found at 4 hours soaking, 20 minute steaming and cabinet drying of sorghum sample at soaking temperatures of 80^{0}C.

Hardness of sorghum sample was found to be lowest (4.11 Kg/cm^2) at 60^{0}C for 2 hours soaking, 10 minute steaming and sun drying, which was found to be more than that of un-parboiled sorghum sample. This increase in hardness of grain may be due to gelatinization of starch of grains during its parboiling process which in turn cause its better milling quality.

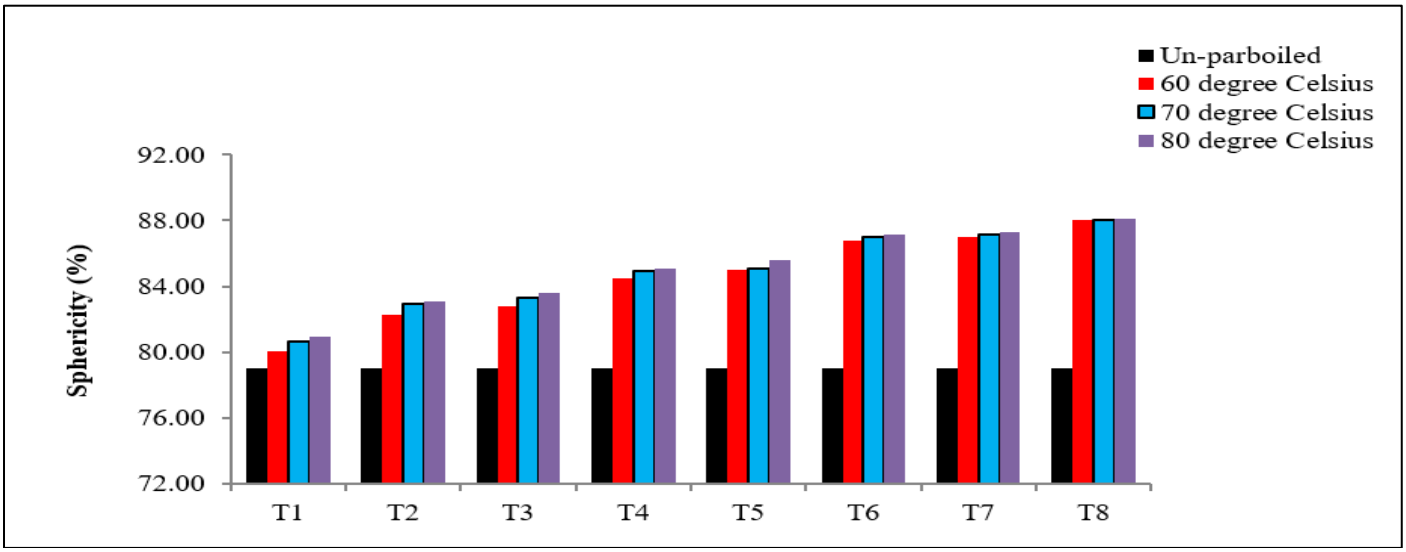

Fig 2: Sphericity of Sorghum Sample

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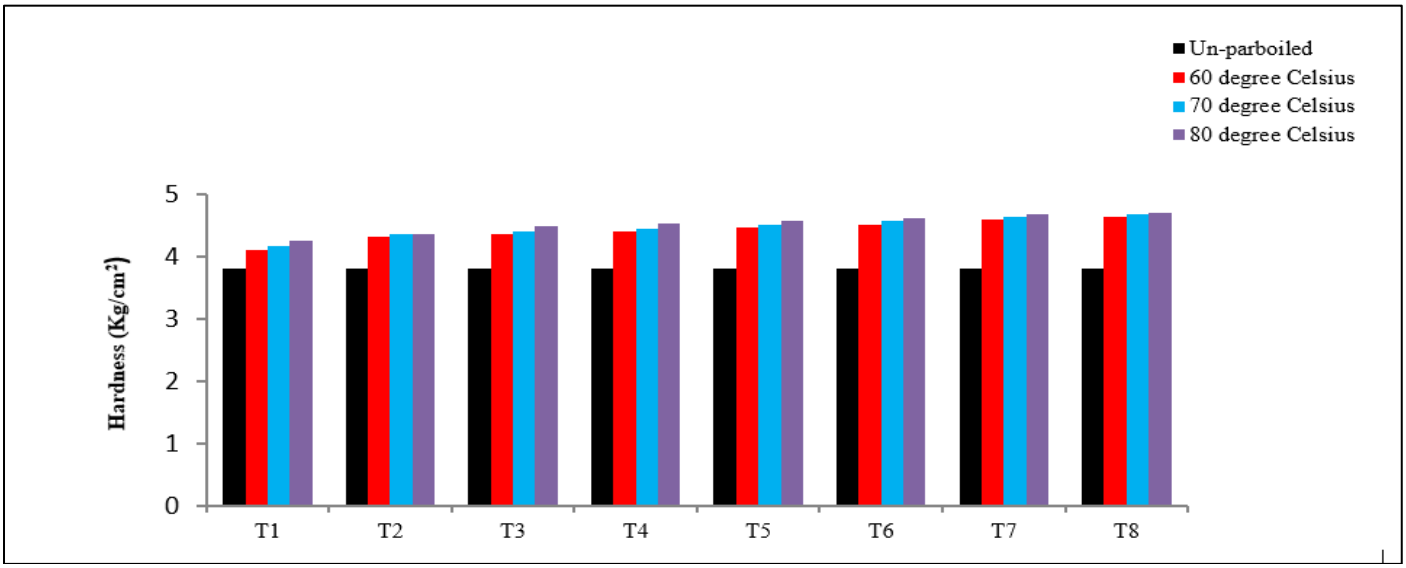

Fig 3: Hardness of Sorghum Sample

C. Milling Characteristics of Sorghum Sample

From Table 1 it was observed that, amount of matter left over IS 100 sieve after milling of un-parboiled sorghum sample ranged between 12.10 to 16.00 gm, whereas for all the parboiled samples, amount of matter left over IS 100 sieve after milling ranged between 8.20 to 10.30 gm. This decrease in amount of matter left over IS 100 sieve after milling of parboiled sorghum samples (i.e. increase in milling characteristics of parboiled sorghum samples) is due to fact that there is increase in the hardness of the grains after its parboiling process.

Milling percentage of un-parboiled sorghum sample was found to be 85.6%. For parboiled sorghum sample milling percentage was found to be maximum of 91.8% for sample T8 at 80^0C, whereas it was found to be minimum of 89.7% for sample T1 at 60^0C.

Table 1: Amount of Matter Left Over IS 100 Sieve After Milling

Treatment No.	Unparboiled Sample	60^0C	70^0C	80^0C
T1	14.4 gm	10.30 gm	10.13 gm	10.05 gm
T2		10.11 gm	9.98 gm	9.95 gm
T3		9.96 gm	9.71 gm	9.67 gm
T4		9.83 gm	9.59 gm	9.37 gm
T5		9.37 gm	9.22 gm	9.15 gm
T6		9.05 gm	8.97 gm	8.90 gm
T7		8.53 gm	8.45 gm	8.25 gm
T8		8.31 gm	8.23 gm	8.20 gm

D. Nutritional Properties of Sorghum Sample

Considering the hardness value of 24 sorghum samples, sample with maximum value of hardness (sample T8 at 80^0C) was used for determination of nutritional properties as it yields maximum milling and it was compared with nutritional properties of un-parboiled sorghum sample (Table 2). It was observed that there was 11.3% increase in carbohydrate content, 1.1% increase in protein content, 33.1% increase in fat content and 58.3% increase in ash content of parboiled sorghum sample.

This may be due to the fact that because of parboiling process, nutrients from outer coat of sorghum grains got absorbed in the endosperm. These results are similar to parboiling of rice as the amount of protein and vitamins increases in parboiled rice (Islam *et al*., 2002).

Table 2: Nutritional Properties of Sorghum Sample

Sr. No.	Parameters	Un-Parboiled Sample	Parboiled Sample
	Carbohydrates	71.29 gm	79.35 gm
	Protein	8.17 gm	8.26 gm
	Fat	1.69 gm	2.25 gm
	Ash	0.96 gm	1.52 gm

IV. CONCLUSIONS

- Physical quality of parboiled sorghum grains in terms of its hardness was found to be 24% more than that of un-parboiled sorghum grains.
- Milling percentage of parboiled sorghum grains was increased maximum up to 6.2%.
- Nutritional quality of parboiled sorghum grains was found to be increased by 11.3% for carbohydrates, 1.1% for protein & 33.1% for fats.

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- Thus, parboiling of sorghum grains was found to be effective in terms of increase in its milling and nutritional quality when soaking of grains at 80^0C for 4 hours followed by 20 minute steaming and then cabinet drying till the moisture of grains reaches to 12% (dry basis).

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