COMPLETION REPORT

DEVELOPMENT OF CONTINUOUS WET CUM DRY GRINDER FOR GRINDING WAXY RICE FOR USE IN THE STATE OF ASSAM

PROJECT FUNDED

By

DEPARTMENT OF SCIENCE AND TECHNOLOGY

Submitted by

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1.0 Project Details

Project Title:	**Development of continuous wet cum dry grinder for grinding waxy rice for use in the state of Assam**
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Duration:	**Two + One (Extension) - Years**
DST Contribution:	**Rs. 23.616 lakhs**

2.0 Overview of project

Milestones	Status
1. Conceptualization of wet grinding machine for waxy rice.	Completed
2. Preparation of detailed engineering drawings.	Completed
3. Fabrication of wet grinding machine.	Completed
4. Continuation of Fabrication of wet grinding machine incorporate improvements and modifications.	Completed
5. Large-scale runs of wet grinding machine.	Completed
6. Field trials and demonstrations to selected users.	Completed
7. Preparation of completion report for the project	Completed

2.1 Outcome of the project

• Equipments	-	2
• Proposed publications	-	1
• Poster	-	1
• Patent	-	1
• Research utilization	-	1
• Commertialization (expected)	-	5

3.0 Introduction

Waxy rice contains very less (0-2%) amylose content and large amount of amylopectin. However, the presence of contaminant translucent grains may lead to arbitrarily extend the amylose content of waxy rice to 0-5% to accommodate more samples (Juliano et al., 1989). It is grown mainly in Southeast and East Asia. In waxy rice the endosperm is opaque because of the presence of micropores on the surface of the granules and also the cavities or hollow spaces inside the granules (Tashiro and Ebata, 1975); waxy rice and its starch granules have lower densities than non waxy rice. Waxy rice is used as whole rice after milling and as flour. The rice is used in variety of ethnic food products especially in Southeast and East Asia. When cooked, waxy rice grains are very sticky and glossy. Waxy grains may be short, medium and long grain types. Waxy rice has low gelatinization temperature and soft gel consistency (Juliano, 1993).

Assam is a state which is rich in different varieties of indigenous waxy rice often called as bora chaul. Bora chaul is the core ingredient of Assamese speciality savoury and snack items and is widely used for making different traditional food products like sweets and snacks including Narikolor pitha, Til pitha, Ghila pitha, Tel pitha, Kettle pitha, etc., rice cakes (tekeli pitha) and mithoi etc. Out of all traditional products, til pitha has its own special place in Assamese society. It is generally made on special occasions like Bohag Bihu, harvesting festival of Assam (Magh Bihu), marriages, rituals and ceremonies. Til pitha i.e sesame pitha is a toasted waxy rice flour roll stuffed with mixture of roasted and ground sesame seeds and grated jaggery.

Traditionally, in rural areas, for making til pitha, the waxy rice is soaked in excess water overnight. Next day water is drained and the soaked rice is allowed to surface dry. It is then ground into fine powder by foot or hand pounder and the powder is kept pressed and covered with a moist cloth until use. Generally, the pitha is prepared immediately on the same day the rice flour is made. The efficiency of rice flour to make the pithas decreases as rice flour particles lose its stickiness with time. A handful of moist waxy rice flour is put and spread to form a thin sheet over the heated frying iron pan maintained at medium heat. The mixture of roasted ground sesame seeds and jaggery is put over the rice flour sheet and the sheet is rolled into a cylindrical tube and slightly pressed. Instead of sesame seeds, grated coconut mixed with sugar can also be used as stuffing. Til pitha is served with milk or tea.

Although til pitha is prepared in every home in villages during various occasions, it uses conventional grinding system like the hand and foot operated milling and pounding unit (*dheki*) which is time consuming as well as requires physical strength. If *dheki* is not available people go for alternative machines like mixture grinder. But a common problem with mixture grinder is that the powder gets dried up quickly and therefore cannot retain the moisture required for making til pitha and the pitha breaks up while rolling. Also the ground rice flour undergoes partial gelatinization particularly because of heat generated inside the grinder cup. This occurs because waxy rice has a low gelatinization temperature and the soaked rice has moisture content around 22-25%. Hence the use of mixture grinder for this purpose is very limited. There is therefore, a need to have a grinder that can grind hydrated waxy rice into moist flour that is fine and free of lumps.

The grinder developed in the DST project was tested for making til pitha. The changes in the physicochemical properties of the flour in the toasting process were also investigated.

Several traditional sweets are produced and consumed in North eastern states of India on festivals. Assam, has a traditional sweet named T*il pitha,* which is very popular and consumed in large volumes. *Til pitha* is made from waxy rice flour, that has thil (gingelly) and jaggery as filling. In appearance, the *pitha*, is a very thin sheet of baked rice flour and rolled by stuffing a mixture of *Thil and jiggery* inside. Traditionally, for preparation of *pitha*, region-specific whole waxy rice is soaked to full saturation and drained well to make the rice surface-dry before powdering in a dheki. This dheki is a traditional hand and foot operated milling and pounding unit. The moist rice gets powdered because of the pounding action of the dheki. The moist flour thus obtained is kept covered and a fistful of the powder is spread on a flat hot griddle (tava) and cooked for about a minute or so and rolled to cylindrical shape (with stuffing at the center). During cooking, the rice flour being waxy and moist, binds together, which can be rolled over as a cylindrical roll. Before rolling, gingelly powder and jaggery mix is spread at the center and the sweet is therefore dry and crisp. The dheki being a traditional device, the modern house holds can be equipped with a mechanized device equivalent to the traditional dheki. All the preparatory operations like powdering of waxy rice etc., are currently carried out manually by hand or leg pounding which is unhygienic. In view of the above, it is thought desirable to design a device equivalent to dheki, as a modern electric grinder. It was observed that grinding of partially wet waxy rice was a real challenge, due to formation of lumps during grinding. However, partially dried rice can be used for powdering in two stages from coarse to fine.

Accordingly, if a Table top grinding device is made available for grinding of waxy rice, it will reduce drudgery on the part of the house wife and impart hygiene in preparation of *Thil pitha*. Further, based on the grinding capacity of the device, the traditional sweet can be produced in large-scale for mass feeding.

4.0 Justification

Equipment relates to Table top continuous wet cum dry grinding machine developed for wet and dry grinding of waxy rice as well as for preparation of batter such as dosa, idli etc. Invention is useful for continuous wet cum dry grinding of food materials, which are used for preparation of snack foods and other adjuncts during large-scale preparation for mass feeding. Continuous wet cum dry grinding device for foods can produce powder/batter of rice, urdh dal and spices used for the preparation of pastes for Sambar etc. Powder/batter, obtained continuously by using this device, are of uniform particle size. Food materials employed are waxy rice/rice, urdh dal, spices while other additives in different combinations.

The machine is used for grinding of food materials and has a pair of grinding wheels. Gap between the stationer and rotary wheel is adjusted by axial movement of the stationery wheel and relative motion between the pair of grinding wheels, which induces shear. Soaked materials, fed into the grinding zone along with water, experiences shear when they come in between the wheels, thereby resulting in reduction of particle size (coarse). Further reduction in particle size is achieved by reducing the gap between the wheels. The device has the prospect of applications in households for day-to-day grinding of food materials in kitchens.

4.1 Need for undertaking of proposed work/project

Presently grinding of waxy rice in the north eastern states, especially Assam, is carried out manually by using hand/foot operated dhekhi. In south India, wet and dry grinding machines available in market are of batch type and are used for dry and wet grinding of cereals, pulses and spices. The major problem in these grinding machines is non-uniform particle size and manual handling of raw materials which leads to poor and unhygienic end product. They are not suitable for fine grinding. These units are tedious in operation and labor intensive and time consuming in their operation. In case, a suitable table top continuous device is made available for powdering of waxy rice for *Thil pitha* and wet cum dry grinding of cereals, pulses and spices which would result in reduction in hardship, besides a clean and hygienic end product having uniform particle size of ingredients. The continuous wet cum dry grinding machine would benefit the society at large and food industry in particular. Realizing the importance and necessity, research work was initiated for the design and development of a wet cum dry grinding machine.

5.0 Objectives

The main objective of the project is to design and develop table top continuous wet cum dry grinding machine for grinding of waxy rice for the preparation of *Till pitha* and other similar traditional sweets produced in North- Eastern states of India. This mechanized grinder will overcome most of the drawbacks of the existing grinding equipments available in the market.

6.0 Details of the Work done under the project

The following section discusses in detail the work carried out under the project with a view to design and develop new machines for continuous wet cum dry grinding.

6.1 Materials

Six rice varieties namely Aghuni Bora (AG), Bhogali Bora (BG), Dang Buni (DB), DRB (dark brown bran colour, variety not yet identified), DRBH (dark brown colour bran and husk, variety not yet identified), and Joha Bora (JB), were obtained for the study from two different places. Aghuni Bora and Bhogali Bora were procured from Regional Agricultural Research Station (RARS), Titabar, Jorhat, Assam while DB, DRB and DRBH were procured from a local farmer at Khoirabari village in Udalguri District, Assam.

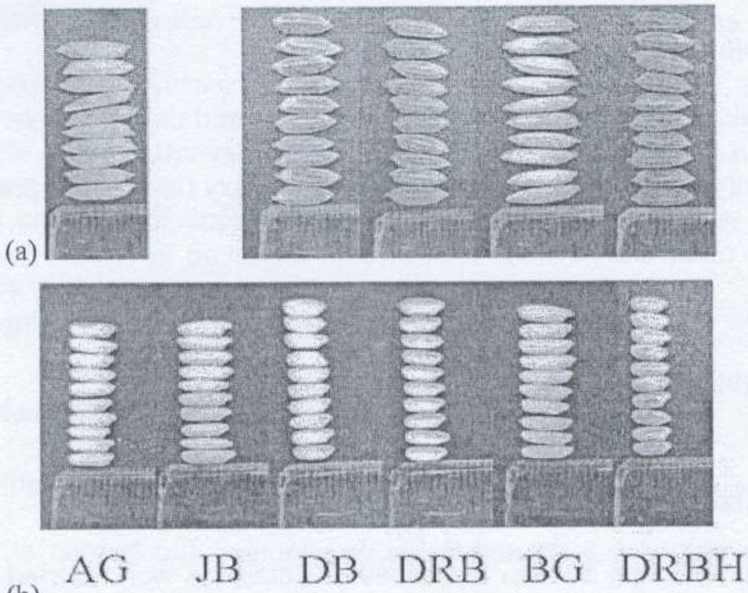


Fig.1 : Images of (a) paddy and (b) rice of collected samples.

6.2 Methods

Particle size analysis

Rice kernels (250 g) were soaked for 3 h in excess water, surface dried at room temperature for 30 min and ground into powder in the developed grinder. The rice powder was analyzed for size distribution in a sieve shaker with sieve mesh sizes of 106, 150, 212, 300, 425 μm. The sieves were arranged in a descending order of the sizes from top to bottom in a sieve shaker and vibrated for 30 min. The weight of the rice powder retained on each sieve was determined.

Physicochemical properties

All the six rice varieties and pitha prepared from them were analysed for moisture content by gravimetric method using hot air oven at 105°C for 24h. Protein, fat and ash contents were determined using standard Kjeldahl distillation method, soxhlet extraction method and muffle furnace, respectively (AOAC, 1999); gel consistency was determined according to Cagampang et al. (1973); alkali degradation was done following the method of Bhattacharya and Sowbhagya (1979); amylose content of rice and pitha flour was determined using the simplified method of Sowbhagya and Bhattacharya (1979).

Cooking time

The cooking time was determined according to the method of Himjyoti et al. (2014). Whole rice (2g) kernels were soaked in 20 ml distilled water for 30 min at room temperature (27±1°C) and cooked at 100°C by open steaming in an autoclave in the same water used for soaking. The cooking was continued until no white core was left in the kernels when pressed between two clean glass slides. The time at which 90 % of the kernels were translucent was considered as the cooking time of that sample.

Cooked Rice Texture

Texture profile analysis (TPA) of the cooked grains was performed using Texture Analyzer (TA.HD plus, Stable Micro Systems, UK). Briefly, 20 g samples of raw rice kernels were cooked as per their cooking times and allowed to cool for 15 min at room temperature. A single kernel was placed inside the test cylindrical probe of 36 mm fitted to 5kg load cell and two cycle compression test was performed by compressing the grain to 50% deformation at a test speed of 0.5 mm/s, pre test speed of 2 mm/s and post test speed of 5 mm/s (Lu et al., 2013). The time between two chews was 5 s. The TPA parameters namely hardness, cohesiveness, gumminess, chewiness and resilience were computed using the inbuilt software (Exponent Lite).

Preparation of til pitha

Bora rice was soaked for 3 h in excess water and water was allowed to drain for 30 min. Kernels were ground into powder in the developed grinder and sieved with 425μm sieve. The moisture content of the rice powder was 21±2% (wb). Powder was transferred to a bowl and pressed down firmly and kept covered with a damp cloth until use to prevent moisture loss. In the mean time, black sesame seeds were lightly roasted and ground into coarse powder using a mortar and pestle. Sesame powder was then mixed with grated jaggery. Fig. 2 presents the flowchart of the pitha making process.

An iron girdle (tawa) was heated on the gas flame and maintained at medium flame

↓

A ladle of rice powder was put in the middle of the pan

↓

Rice powder was spread immediately to a big sizes puri with the back of the ladle

↓

Sesame and jaggery mix was placed in the centre

↓

Allowed the rice to set a little

↓

One side was lifted with the edge of a spatula and rolled into a cylindrical shape

↓

Pitha was obtained

↓

Pitha was turned over and removed from pan

↓

Allowed to cool at room temperature

Fig. 2 : Flowchart of preparation method of til pitha

Texture of til pitha

Texture analysis of pitha was done using Texture Analyzer (TA.HD plus, Stable Micro Systems, UK). Two cycle TPA test was performed for hardness, fracturability, springiness, cohesiveness, gumminess, chewiness and resilience. A 100 kg load cell fitted with a 75 mm probe was used to compress the pitha sample of about 10mm length with a pre test speed of 2 mm/s and post test speed of 5 mm/s. Analysis was performed with three replicates for the pitha sample prepared from all six bora rice varieties.

RVA analysis

Pasting properties of rice flours and pitha flour (10% w/w; 28g total weight) were tested in duplicate using Rice1 profile of a Rapid Visco analyser (RVA Starchmaster2, Newport Scientific Instruments). Each sample suspension was held at 50°C for 1min, heated to 95°C at a rate of 12.16°C/min, kept at 95°C for 2.5 min then cooled to 50°C at a rate of 11.84°C/min where it was held for 2min. The peak viscosity (PV), hot paste viscosity (HPV), and cold paste viscosity (CPV) were recorded in the instrument and breakdown (BD) and setback (SB) were calculated. HPV = minimum viscosity at 95°C, CPV = final viscosity at 50°C, BD = PV - HPV and SB = CPV- HPV.

XRD

The rice flour samples and the pitha flours were conditioned at 50% relative humidity for 5 days prior to this experiment in order to attain uniform moisture content in the samples. WAXS diffractographs were obtained with an Xray diffractometer (Miniflex, Rigaku, Tokyo, Japan) with a K value of 1.54040 operating at 30 kV acceleration potential and 15 mA current with a copper target. The scanning range was 10–40° of 2 θ values with a scan speed of 8° 2θ/min. The total area under the curve and the area under each prominent peak was determined using OriginPro 8.0 software package and the percentage crystallinity was determined.

% Crystallinity = (Area under peaks/Total area) ×100.

Granule Morphology

The raw waxy rice flour samples and the pitha pieces were mounted on scanning electron microscope (SEM) stubs using double sided adhesive tape and were coated with gold. The scanning electron micrographs were taken at 1000X, 4000X and 5000X operating at an accelerating voltage of 20kV.

6.3 Design and development of Continuous Wet cum Dry Grinder.

As the grinding operation involved in the unit being shear (in principle), basic information such as shear stress and shear force required for grinding of rice has been collected from the literature.

Three variants of the grinding machine were designed and fabricated (Two motorized variants and one hand operated variant). In order to have the maximum torque available for the given power of the motor, the model having a flat silicon carbide (as shown in Figures-3 and 4) wheel was replaced by an improved model having conical carborundum wheels (as shown in Figures - 5 to 8).

As a starting step, conceptual drawing was prepared followed by a detailed engineering drawing (as shown in Figures-3 and 6) for continuous wet cum dry grinder. Design drawings were provided to the industrial partner for undertaking the fabrication. The present invention is IPR protected by an Indian patent bearing; Patent application Number: 321/Del/2015. The design comprises of a main frame which houses all the parts of the machine. An electric motor, having one half of coupling at the end of the shaft, is fit inside the main frame through a set of fasteners and the electric supply to the motor is provided by a set of switches. One end of the drive shaft is fit with another half of the coupling and mounted inside the bearings which in turn is mounted inside a bearing housing and welded to the collector. Other end of the shaft carries a truncated conical (male) silicon carbide wheel and a primary grinding blade is mounted on the silicon carbide wheel and is firmly held to the drive shaft by a nut. Design of the grinder is based on a set of carborundum wheel for grinding. A top cover is screwed to the collector wherein the particle size of the ground material can be varied by rotation of the top cover which is attached to a matching silicon carbide (female) wheel. A feed hopper is mounted on top cover.

Power requirement for the motorized grinder is estimated to be around 750 W. Operating speed of the grinder is around 3000 RPM and the capacity of wet as well as dry rice, is in the range of 18-20 kg/h.

Hand operated version of the wet cum dry grinder is as shown in Figures - 9 and 10. Several trials were also conducted to evaluate the flow pattern of the ground materials during grinding operation and the pattern of flow is depicted in Figures – 11 and 12.

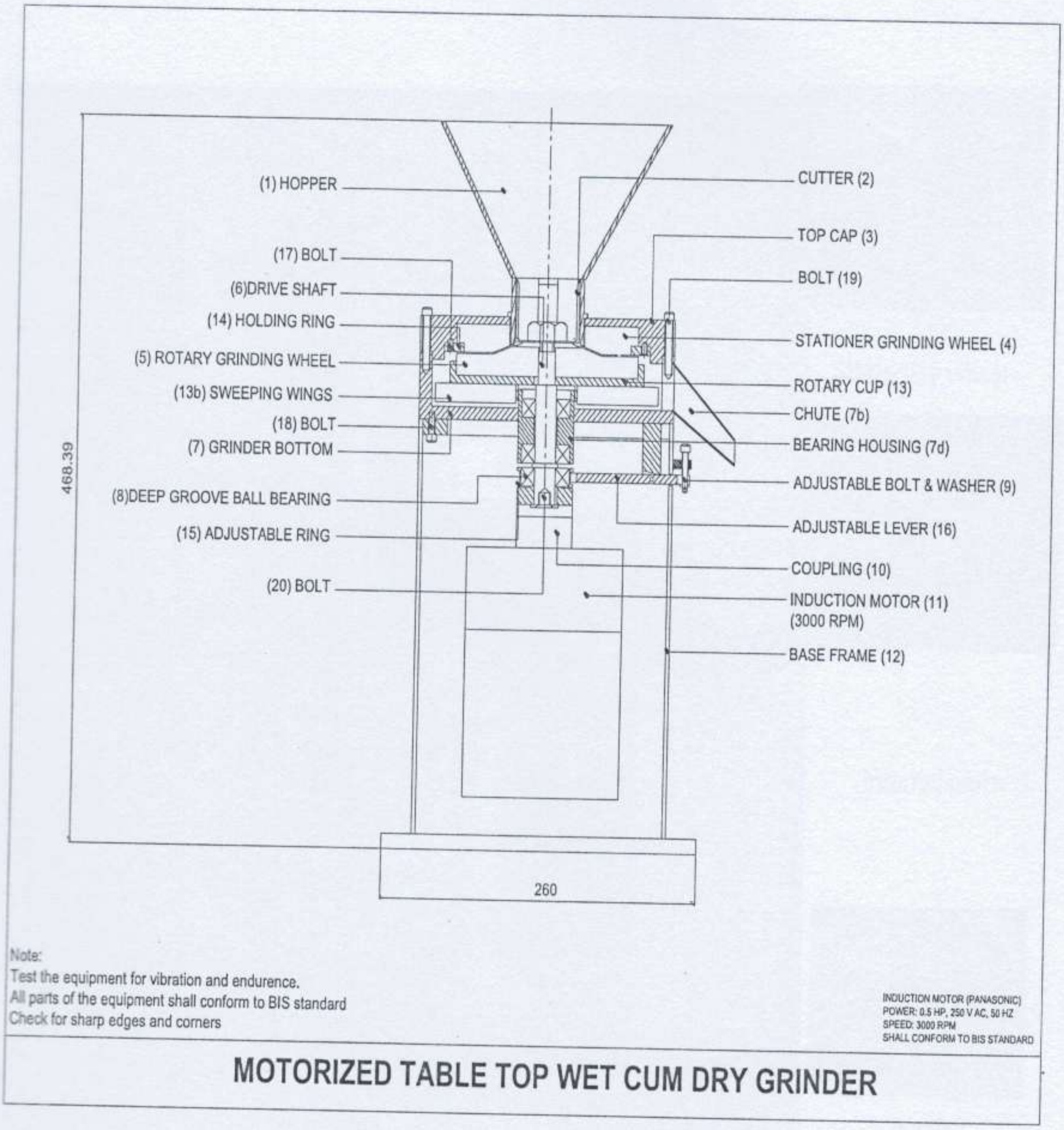


Fig. 3 : Engineering drawing of truncated conical continuous wet cum dry grinder

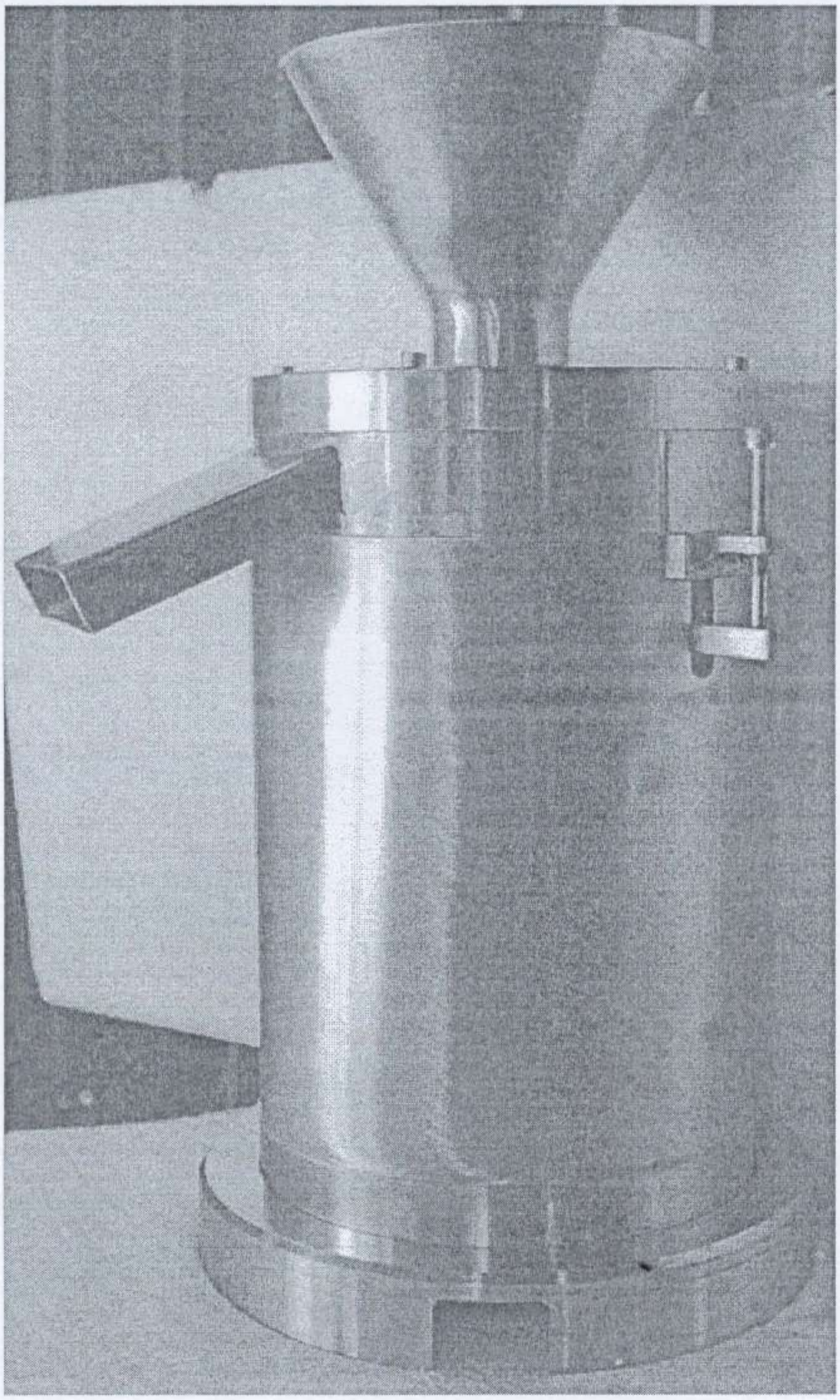


Fig. 4 : Table top continuous wet cum dry grinder.

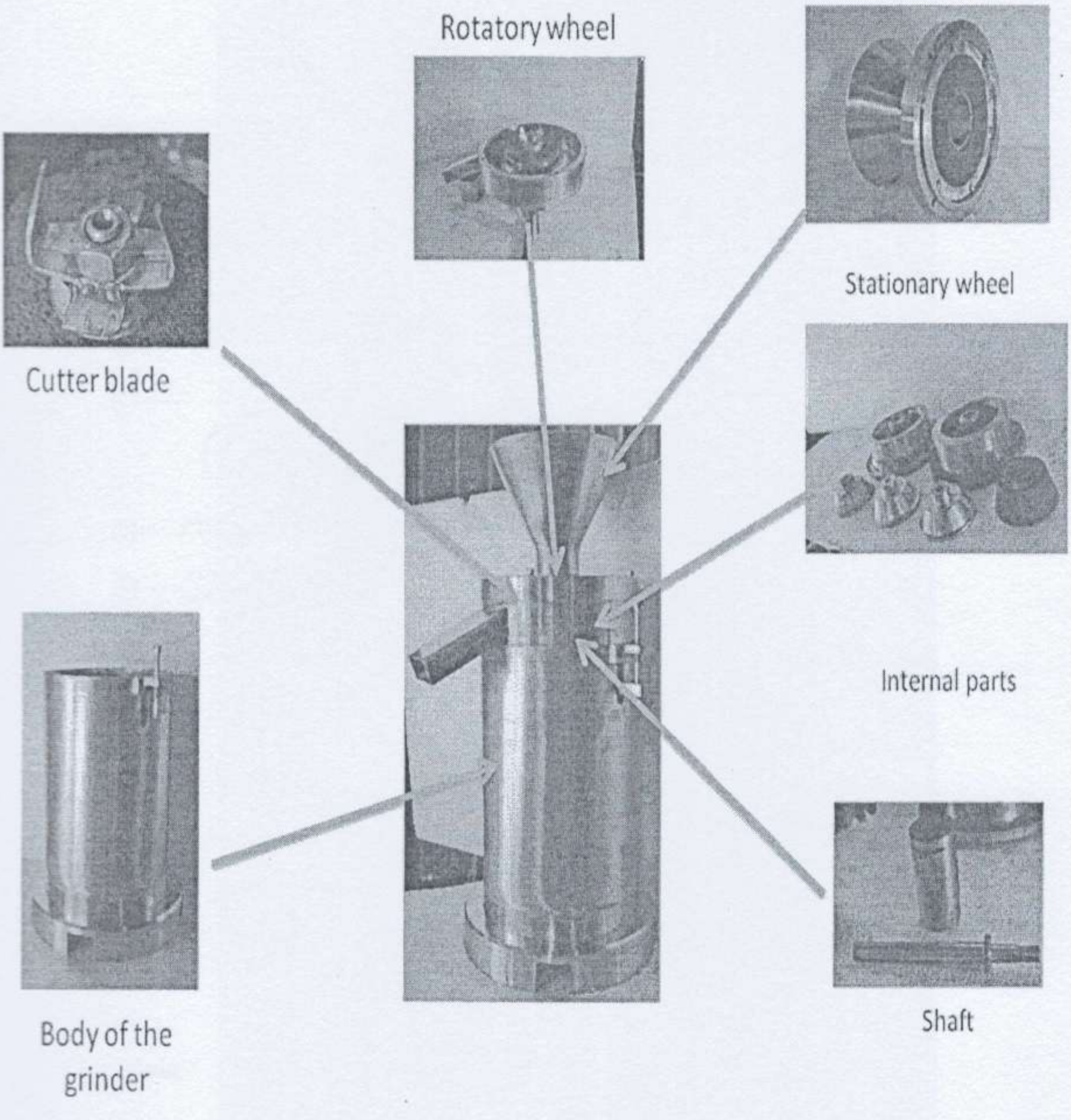


Fig. 5 : Various parts of continuous wet cum dry grinder.

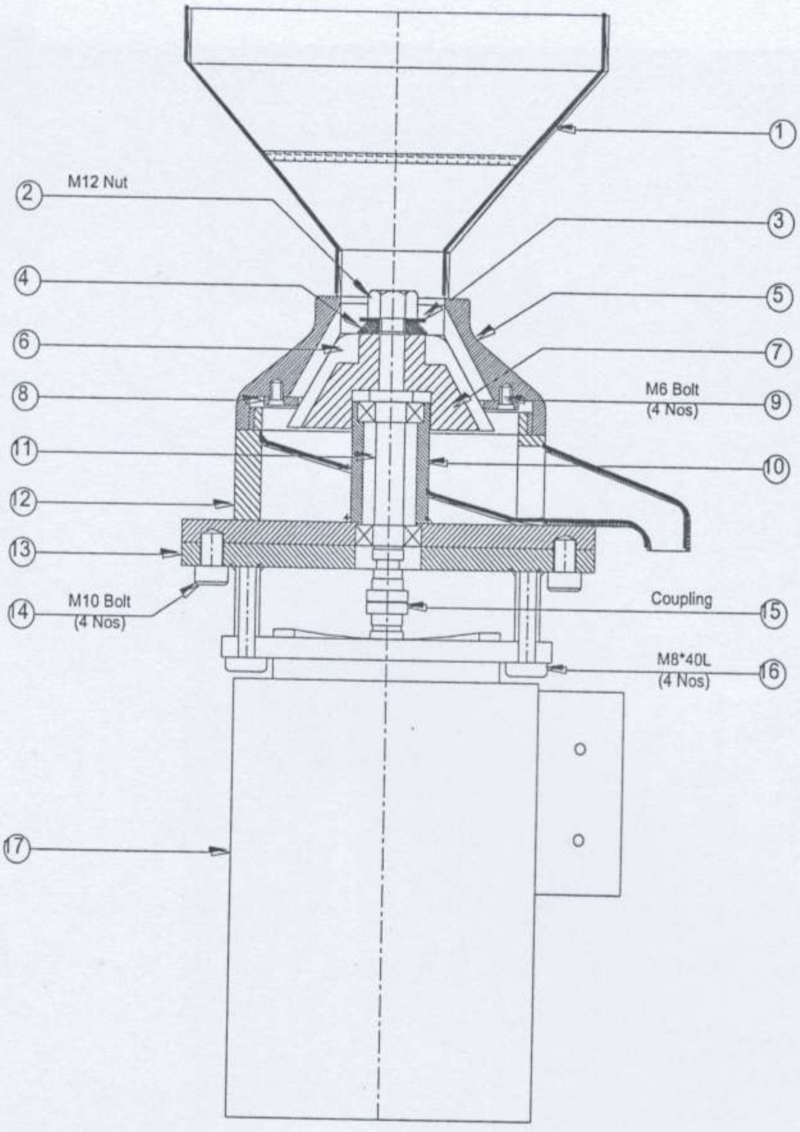


Fig. 6 : Engineering drawing of Modified-Improved continuous wet cum dry grinder.

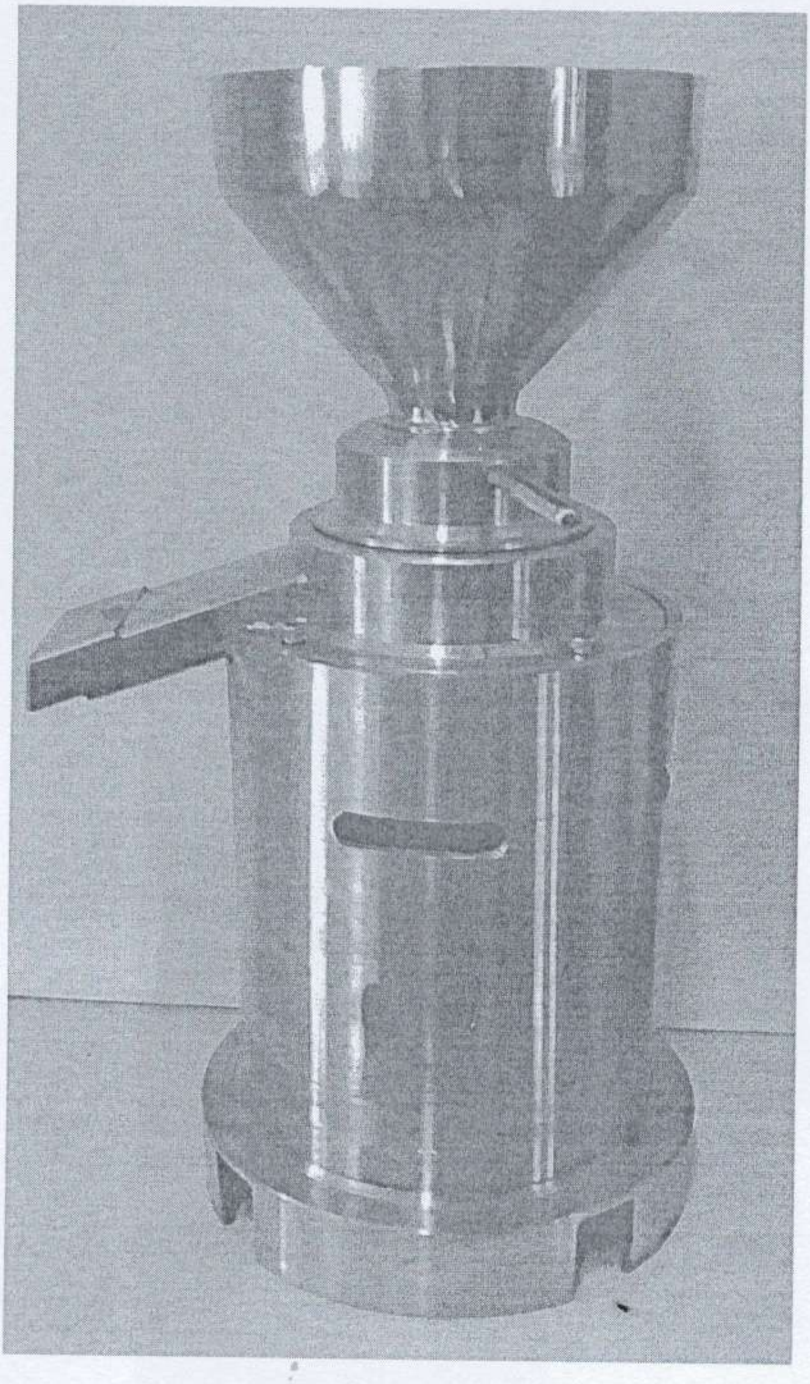


Fig. 7 : Modified / Improved continuous wet cum dry grinder

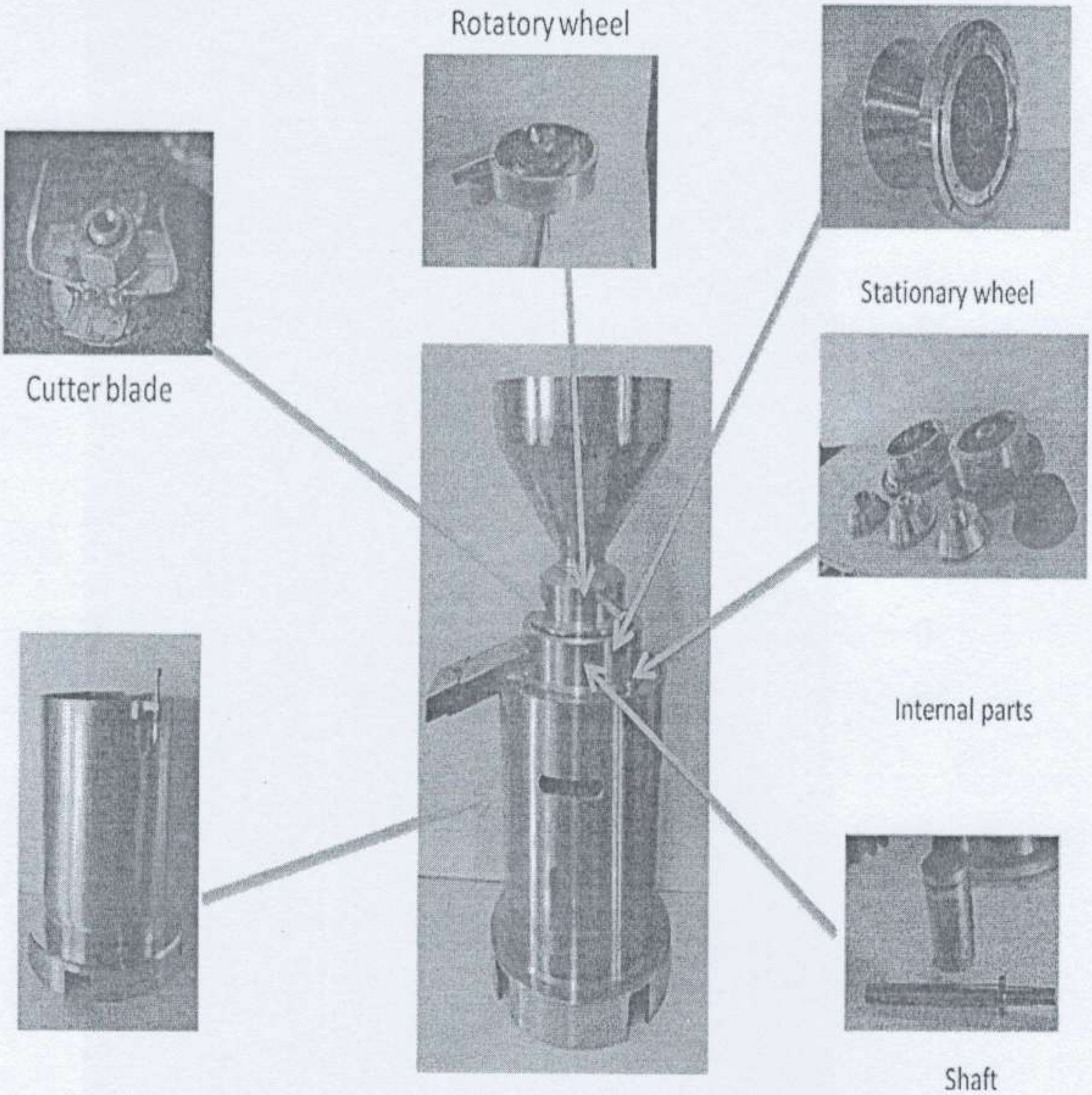


Fig. 8 : Various parts of continuous improved wet cum dry grinder.

Fig. 9 : Hand operated continuous wet cum dry grinders.

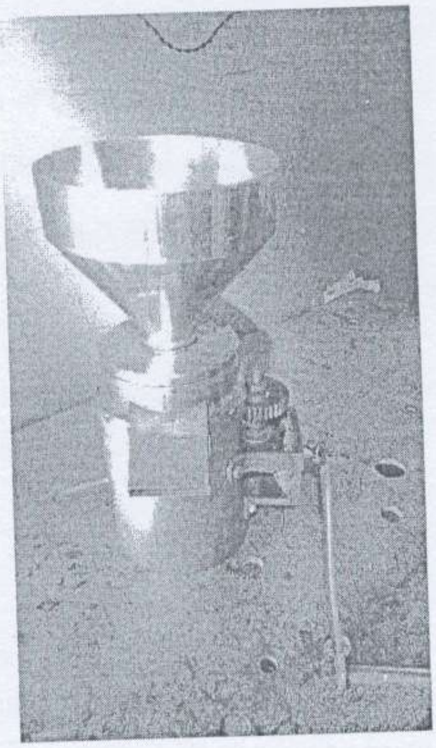


Fig. 10 : Hand operated continuous wet cum dry grind

Detailed Specification of wet cum dry grinder

Since the product is for human consumption, necessary hygiene is of vital importance and all parts in contact with the food material are made of 316 material and the Grinding wheel made with Silicon Carbide. The detailed specifications are given in Table – 1.

The machine was fabricated (shown in Figure-3 and 6) as per the design drawing. Large scale trials were carried out to ensure the machine performance in terms of grinding capacity for which machine was designed. Trials were very satisfactory and often output excess of the rated capacity (> 18~20 kg/hr) was observed.

Sl. No	Description	Value
1	Capacity of Grinder	18~20 kg/h
2	Motor Horsepower	1.0 HP
3	Supply voltage	230 VAC/1 Ph/50 Hz
4	Material of Housing	Stainless Steel
5	Grinding Wheel	SiC (Black wheel with grit size 24~36)
6	Weight of the machine	37 kg (Aprox.)
7	Floor space needed	0.2 * 0.2 m^2
8	Height of the machine	0.5 meter
9	Sound level (min / max)	82 / 79 dBA (avg)
10	Motor temperature rise - dry run	From 26 TO 56°C
11	Dry run temperature rise (body)	From 26 to 29°c

Table 1: Specification of continuous wet cum dry grinder.

Grinding Process

The working of the table top continuous wet cum dry grinder machine is tested for its efficiency by grinding Rice/Urdhal mixture and Ragi/Urdhal mixture. The Rice and Urdhal mixture in the ratio of 1:0.2 was soaked in water (mixture to water ratio of 1:1.1) for 4 hours. The soaked mixture of either Rice/Urdhal mixture or Ragi/Urdhal mixture was fed into the feed hopper and a little amount of water was added for smooth flow of the grain mixture. In case of Rice/Urdhal, after grinding, an increase in volume of batter was observed which was 1.45 times the initial volume of rice and 2.18 times that of Urdhal. In case of Ragi/Urdhal mixture, after grinding, it was observed that the increase in volume of batter was 1.2 times the initial volume of Ragi and 2.18 times that of Urdhal. The primary cutter was found to reduce the size of grain mixture to final particle size of 60 micron both in case of Rice/Urdhal and Ragi/Urdhal mixtures when ground employing the silicon carbide wheels. The ground batter was collected in a container for further processing.

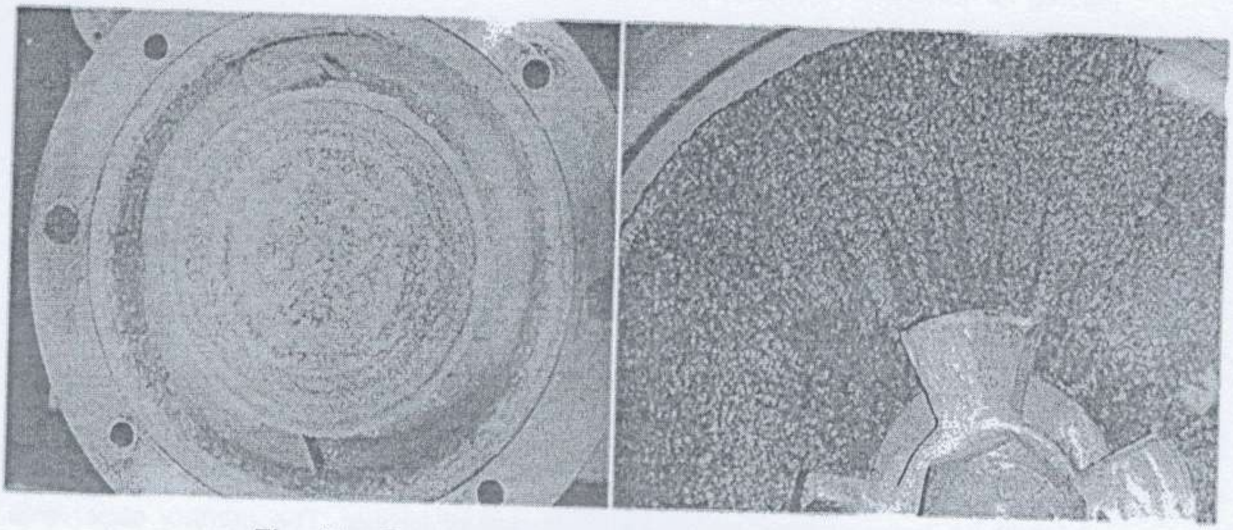


Fig. 11 : Rotating wheel showing batter movement

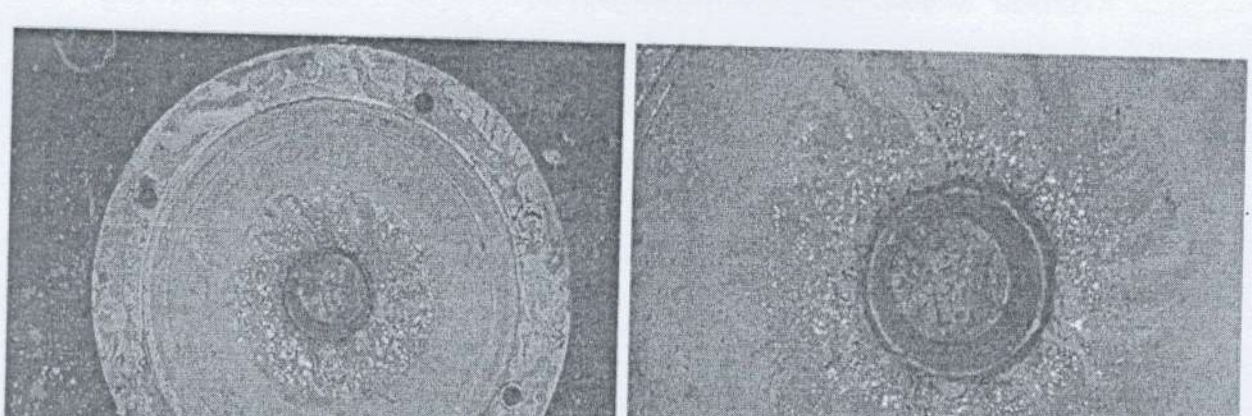


Fig. 12 : Top cover showing batter movement

6.4 Results

Particle size analysis

Table 2 gives the amount of rice flour that is retained over the respective sieves after 30min shaking in the sieve shaker. Highest amount of rice flour is retained over sieve of 300 µm mesh size followed by 212 µm, 150 µm, 106 µm and 425 µm. So the sieve with pore size 425 µm was used further for sieving the ground bora rice flour to make pithas.

Rice varieties	425 µm (g)	300 µm (g)	212 µm (g)	150 µm (g)	106 µm (g)	Bottom collector (g)
AG	6	40.5	35	16	2.5	0
BG	3.5	40	35	17	4.5	0
DB	2	33	32	21.5	11	0.5
DRB	7	42.5	33.5	16	1	0
DRBH	4	45.5	33	13	4.5	0
JB	2	33	36	23	5	0.5

Table 2. Weight of rice flour retained on different mesh size sieves

Physicochemical properties

The values for different physicochemical parameters are listed in Tables 3 and 4. The moisture content of the raw rice varieties was in the range of 10.5-11.51% (wb). The observed moisture content range was in the acceptable range. Moisture content indicates better stability against breakage and good storability. Also it signifies keeping quality of starch and its storage stability (Maeda et al., 2004; Falade et al., 2014). Amylose content of AG, BG, DB, DRB, DRBH and JB was 2.77, 2.4, 2.95, 3.37, 3.34 and 3.46 % respectively and can be categorised as waxy rice. Protein and fat content of AG and BG were higher than the other four varieties which showed almost similar protein and fat content. This kind of trend was reported by Himjyoti et al. (2012). This may be because these are improved varieties released by Assam Agricultural University.

Ash content of AG, JB, DB, DRB, BG and DRBH was found to be 0.37, 0.48, 0.54, 0.63, 0.61 and 0.51, respectively. Alkali degradation scores of rice varieties were 10.04, 9.5, 12, 8.67, 9.95 and 8.5mm respectively (Table 3). Gelatinization temperature is known as the temperature at which 90% of the starch granule swell by up taking water and disrupt subsequently losing the birefringence or the crystalline structure. According to Cruz et al. (2000), the gelatinization temperature of rice is classified as low (55-69°C), intermediate (70-74°C) and high (>74°C). All the raw rice varieties except JB were found to have low gelatinization temperature according to the alkali scores obtained by alkali digestion test. Gel consistency of AG, JB, DB, DRB, BG and DRBH rice varieties was 94.75, 89, 100, 85, 96.25 and 100 mm respectively (Table 3). Gel consistency indicates the tendency of cooked rice to harden after cooling (Juliano et al., 1979; Falade et al., 2014) and on the basis of gel length, all the rice varieties are categorized as having soft gels (61-100 mm). Alkali spreading value of the rice varieties was in the range 8.5-12 mm.

Rice varieties		Moisture content (%, wb)	Amylose content (%, wb)	Protein (%, wb)	Fat (%, wb)	Ash (%, wb)	Alkali degradation test (mm)	Gel consistency test (mm)
Raw Rice	AG	10.69±0.04	2.77±0.14	8.4±0.49	1.81±0.15	0.37±0.01	13.2±0.05	94.75±2.47
	BG	10.71±0.15	2.40±0.05	9.98±0.49	1.3±0.11	0.61±0.01	13.27±0.45	96.25±1.76
	DB	10.51±0.12	2.95±0.05	5.25±0.04	0.55±0.14	0.54±0.03	12±0.07	100±0
	DRB	11.51±0.15	3.37±0.7	5.25±0.03	0.58±0.07	0.63±0.01	10±0.81	85±0.7
	DRBH	10.57±0.21	3.34±0.09	5.07±0.04	0.4±0.03	0.51±0.02	11±0.03	100±0
	JB	11.17±0.05	3.46±0.06	5.07±0.05	0.39±0.04	0.48±0.02	10±0.55	89±1.41
Pitha	AG	16.76±0.35	3.14±0.09	1.57±0.02	0.12±0.02	0.52±0.025	ND	ND
	BG	17.06±0.13	3.40±.06	1.05±0.01	0.27±0.11	0.54±0.015	ND	ND
	DB	12.95±0.25	5.22±0.11	0.67±0.02	0.07±0.01	0.60±0.01	ND	ND
	DRB	16.35±0.15	5.18±0.09	0.76±0.02	0.07±0.01	0.66±0.02	ND	ND
	DRBH	12.94±0.30	4.59±0.06	1.27±0.01	0.17±0.02	0.43±0.012	ND	ND
	JB	14.16±1.12	4.31±0.11	1.23±0.03	0.22±0.02	0.49±0.01	ND	ND

ND: Not Determined

Table 3. Physicochemical properties of six varieties of rice and pitha

Moisture content and amylose content in the pitha were higher than the raw samples. On the other hand, protein and fat percentage were found to be less in the product and ash content remained almost unchanged. Variable moisture content in the pitha samples may be due to non uniform heating during the preparation of pitha. Increase in amylose content might be attributed to the swelling of starch granules which might have led to partial degradation of the starch granule and caused amylose leaching during pitha making.

Cooking time

Table 4 gives the cooking time of the different waxy rice samples. The cooking time of the rice varieties varied from 10-11 min. Variation in cooking time was in a narrow range and cooking time was lowest in AG. The low cooking time of the waxy rice varieties is attributed to low amylose content of these rice (Dutta et al., 2012) and low gelatinization temperature.

Rice varieties	**Cooking time (min)**
AG	10.00±1. 23
BG	11.00±1.17
DB	11.00±1.00
DRB	10.67±1.57
DRBH	10.33±0.57
JB	10.11±1.00

Table 4. Cooking time of different rice samples

Textural properties

Cooked rice texture

The textural properties of cooked waxy rice varieties, determined by TPA are listed in Table 5. The hardness value of the rice varieties ranged from 153.68-207.39 g. BG showed highest hardness (2017.39g) and DBRH showed the lowest (153.0 g). Adhesiveness value was observed to range from -8.71 to –6.95 g.sec. Cooked rice kernel from DRB showed highest adhesiveness than other rice varieties (–6.95 g.sec) and lowest in JB (-8.71 g.sec). All the six rice varieties showed very little difference in springiness and cohesiveness. BG showed the highest gumminess followed by AG. Relatively high chewiness was observed in BG (52.63 g.mm). Resilience values of all the rice varieties were almost similar, showing similar trend of recovery from deformation during the two cycle compression test. The textural parameters were relatively low in the rice varieties since the amylose content is low which contribute to softness and stickiness in the cooked rice (Lu et al., 2013).

Rice variety	Hardness (g)	Adhesiveness (g.sec)	Springiness (mm)	Cohesiveness (dimensionless)	Gumminess (g)	Chewiness (g.mm)	Resilience (dimensionless)
AG	170.91±15.20	-7.87±2.73	0.74±0.08	0.35±0.03	60.32±8.04	44.32±6.88	0.16±0.02
BG	207.39±13.79	-8.07±3.13	0.73±0.08	0.34±0.02	71.63±4.17	52.63±4.59	0.14±0.01
DB	179.03±16.93	-7.79±4.77	0.71±0.05	0.30±0.02	53.81±7.77	38.01±6.33	0.13±0.02
DRB	166.44±16.71	-6.95±2.06	0.78±0.06	0.33±0.02	54.34±8.92	42.60±7.59	0.14±0.02
DRBH	153.68±27.51	-7.30±2.45	0.80±0.08	0.33±0.01	50.03±8.90	40.03±7.46	0.15±0.01
JB	172.43±11.96	-8.71±2.94	0.80±0.11	0.32±0.01	55.82±4.75	44.92±8.51	0.15±0.01

Table 5. Texture Profile Analysis of cooked waxy rice samples

Results shown are mean of 10 rice kernels±standard deviation

Textural properties of pitha

Values of the TPA parameters obtained for the pithas are listed in Table 6. Hardness, fracturability, gumminess and chewiness of pitha prepared from all bora rice varieties varied widely.

Pitha	Hardness (g)	Fracturability (g)	Springiness (mm)	Cohesiveness (dimensionless)	Gumminess (g)	Chewiness (g)	Resilience (dimensionless)
AG	1900.12±150.28	13.25±6.98	0.27±0.06	0.14±0.00	264.75±26.71	72.40±26.97	0.05±0.01
BG	2987.01±396.77	3.70±2.17	0.21±0.02	**0.17±0.04**	484.88±68.64	102.52±22.23	0.06±0.02
DB	4649.15±374.33	10.28±1.19	0.26±0.06	0.14±0.00	660.74±45.36	171.15±43.49	0.05±0.00
DRB	4511.32±313.853	6.43±.41	0.31±0.02	0.16±0.01	698.78±9.80	222.19±19.94	0.06±0.01
DRBH	4695.49±763.66	3.29±1.53	0.26±0.01	0.16±0.01	725.32±220.66	190.81±48.27	0.06±0.01
JB	3898.80±132.73	3.94±0.17	0.27±0.05	0.15±0.02	560.62±104.62	146.95±0.77	0.06±0.00

Table 6. Texture profile analysis of til pitha
Results shown are mean of 3 till pitha ±standard deviation

The hardness is probably due to hydrothermal process undergone by the powder during the preparation of the pitha since the rice powder contained relatively higher initial moisture content (21±2%, wb). Lowest hardness was found in AG (1900.12g) while DRBH showed the highest hardness (4695.49g). AG showed the highest fracturability (13.25 g) followed by DB (10.28 g) and DRB (6.43 g), whereas other three pithas prepared from JB, BG and DRBH rices showed lower fracturability (3.94 g, 3.7 g and 3.29 g, respectively). The lower fracturability is due to loose packing of the rice flour particles during the spreading of the flour on the pan. Springiness and cohesiveness values for all the samples were less and almost similar as expected. Gumminess and chewiness are two very important parameters for analyzing pitha quality. Lowest value of gumminess and chewiness was shown by AG (264.75 g and 72.40 g, respectively) whereas gumminess is highest in DRBH (725.32 g) followed by DRB (698.78 g) and highest chewiness was seen in DRB (222.19g) followed by DRBH (190.81g). Lower gumminess and chewiness contribute to the eating efficiency of the consumer. As per this requirement pitha prepared from AG was more acceptable. As the product is fracturable, so the resilience is low.

Pasting properties

RVA measures the viscosity of a sample on heating and cooling in presence of definite amount of water. The increase or decrease in viscosity of particular rice flour depends upon the ability of the flour particles to take up water and swell leading to gelatinization with the amorphous region of starch granule in major fraction contributing to this phenomenon. The pasting parameters such as peak viscosity (PV), hold viscosity (HPV), final viscosity (FV), breakdown (BD) and setback (SB) of raw rice flour and pitha flour samples are presented in Table 7. RVA viscograms of raw rice flours were typical of waxy rice starches. Pitha samples exhibited a decrease in PV, HPV, FV and BD and SB. Decrease of these parameters can be ascribed to the breakdown of the amylopectin molecules during the toasting process and also the formation of amylose-lipid complex during the preparation of pitha in presence of moisture in rice flour and the heating temperature (Anderson et al., 2006; Pukkahuta et al., 2008; Sun et al., 2013). Also it showed that the pitha flours were more resistant to swelling than its raw rice flours. These changes can be clearly observed in the viscoamylograms shown in Fig. 13. The changes in the parameters were more severe in BG followed by AG > DB >DRB>DRBH>JB. This might be attributed to difference in moisture content of the rice flour used for pitha preparation.

Samples		PV (cP)	HPV (cP)	CPV (cP)	BD (cP)	SB(cP)
Raw rice flour	AG	2302	1404	1883	898	479
	BG	2596	1456	1965	1140	509
	DB	1899	1321	1895	578	574
	DRB	1678	1218	1770	460	552
	DRBH	1632	699	958	933	259
	JB	1807	858	1199	949	341
Pitha flour	AG	1465	958	1211	507	253
	BG	1072	833	1121	239	288
	DB	1606	987	1360	619	373
	DRB	1256	1006	1329	250	323
	DRBH	868	495	793	373	298
	JB	1760	829	1199	931	370

Table 7. Pasting parameters of raw rice and til pitha samples

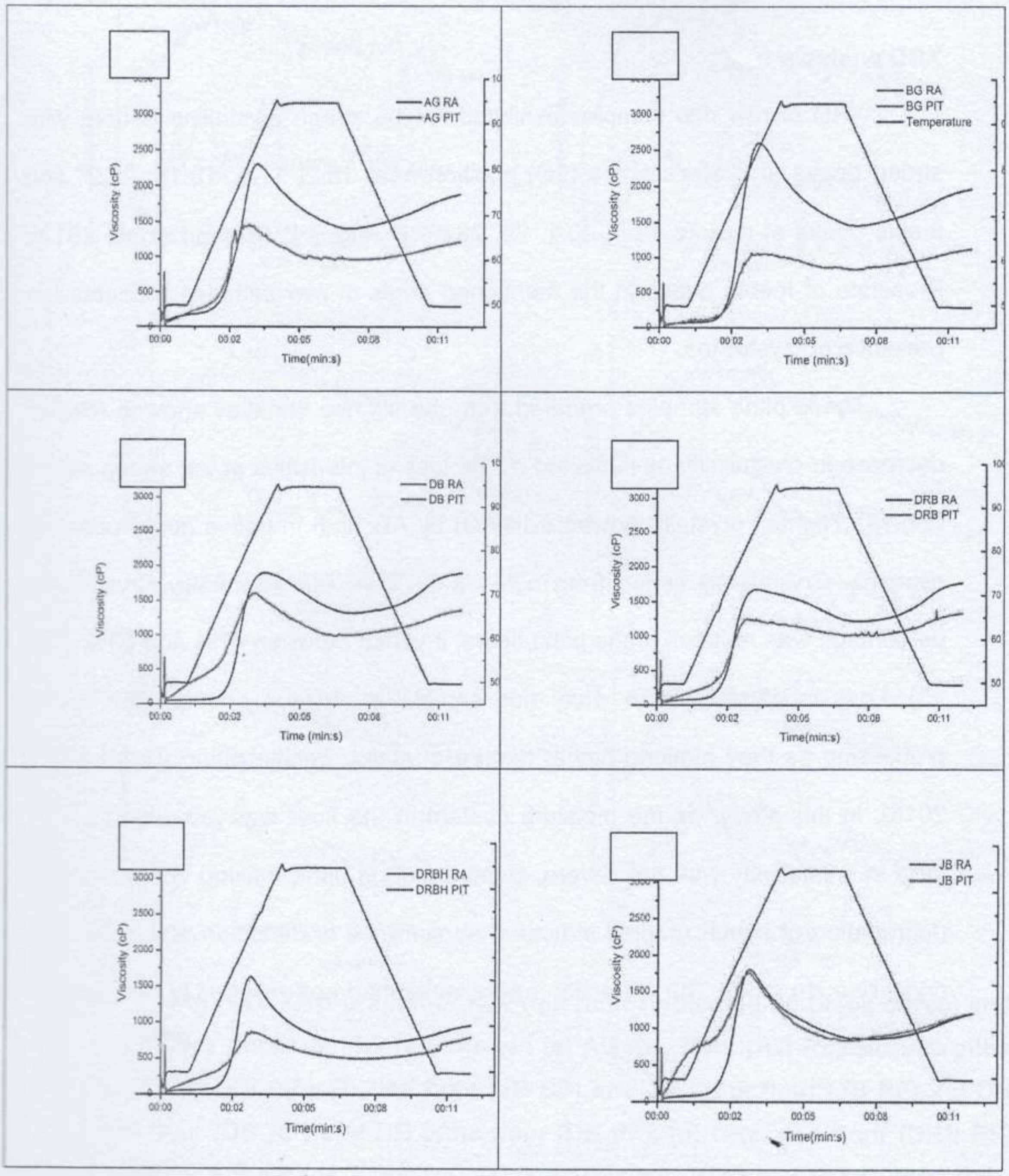


Fig. 13 : RVA pasting graphs (a) AG, (b) BG, (c) DB, (d) DRB, (e) DRBH, (f) JB. Black line indicates raw rice flour; red line indicates pitha flour.

XRD analysis

XRD of raw rice samples exhibited A-type starch crystalline pattern with strong peaks at Bragg's angle (2Θ) position near 15.2, 17.5, 18.15, 23.2° and feeble peaks at around 11.5, 20.1, 22, 26.6°2Θ (Fig. 14) (Prasad et al., 2012). Presence of feeble peaks in the mentioned angle of raw samples indicates the presence of crystallites.

The til pitha samples prepared from the six rice varieties showed relative decrease in crystallinity as indicated by the loss of intensities of the strong peaks (Fig.15). Highest crystallinity was exhibited by AG both in native and processed samples. Crystallinity varied from 53% to 62 % in raw rice flour. Crystallinity percentage was reduced in the pitha flours; it varied between 47% and 53% (Fig. 15). Loss in crystallinity in waxy rice sample is obvious and greater during processing as they attained higher degree of starch gelatinization (Dutta et al., 2016). In this study, as the moisture content in the flour was around 21%, the drop in crystallinity was not severe. Heating during pitha making could result in degradation of starch granule structure, appearance of distortion and defects in crystalline structure. The diffraction peaks weakened and resulted in decrease in crystallinity.

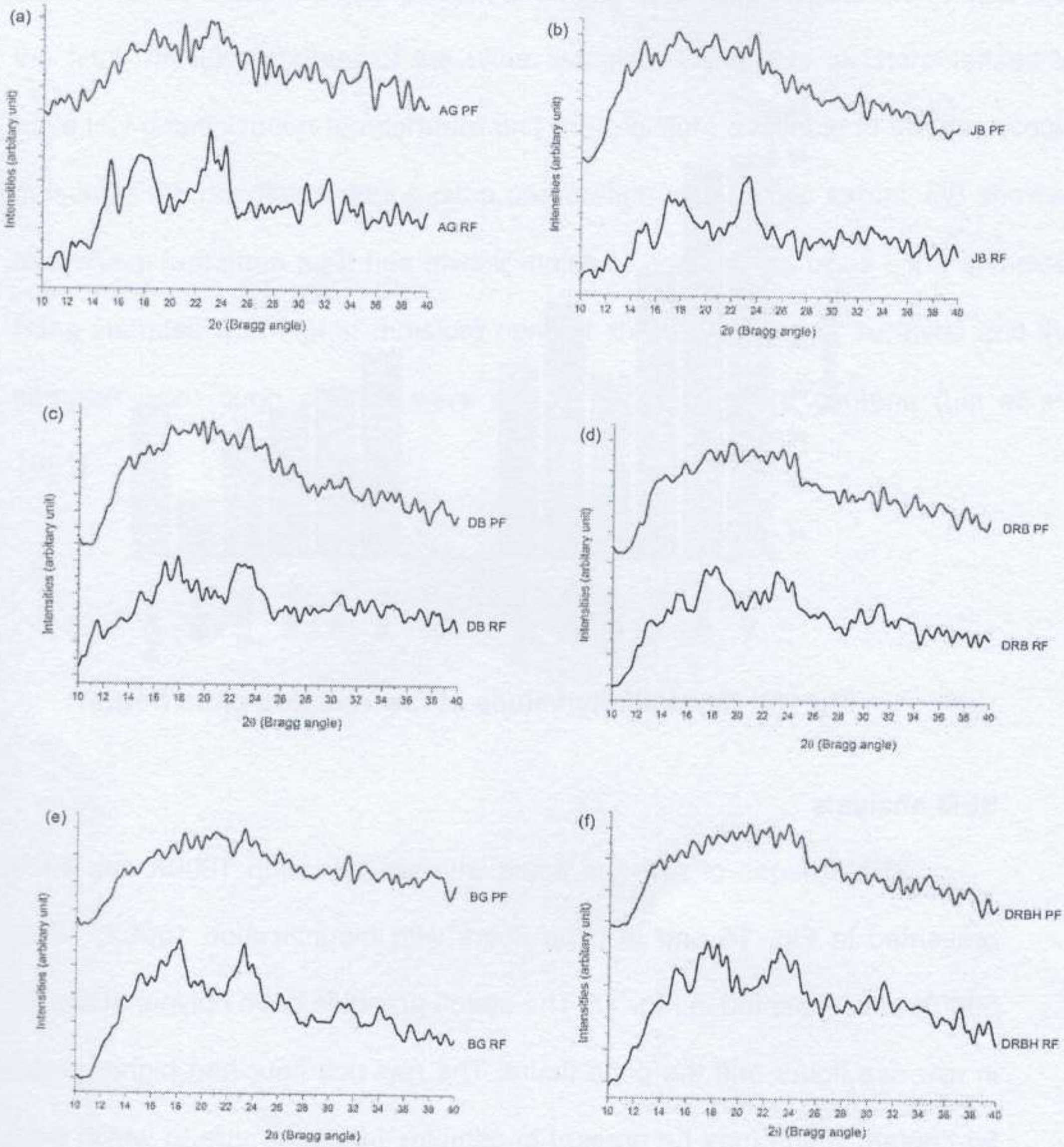


Fig. 14 : XRD graphs of raw rice flour (indicated by black curve) and pitha flour (indicated by red curve) : (a) AG rice flour (AG RF) and AG pitha flour (AG PF), (b) JB rice flour (JB RF) and JB pitha flour (JB PF), (c) DB rice flour (DB RF) and DB pitha flour (DB PF), (d) DRB rice flour (DRB RF) and DRB pitha flour (DRB PF), (e) BG rice flour (BG RF) and BG pitha flour (BG PF), (f) DRBH rice flour (DRBH RF) and DRBH pitha flour (DRBH PF).

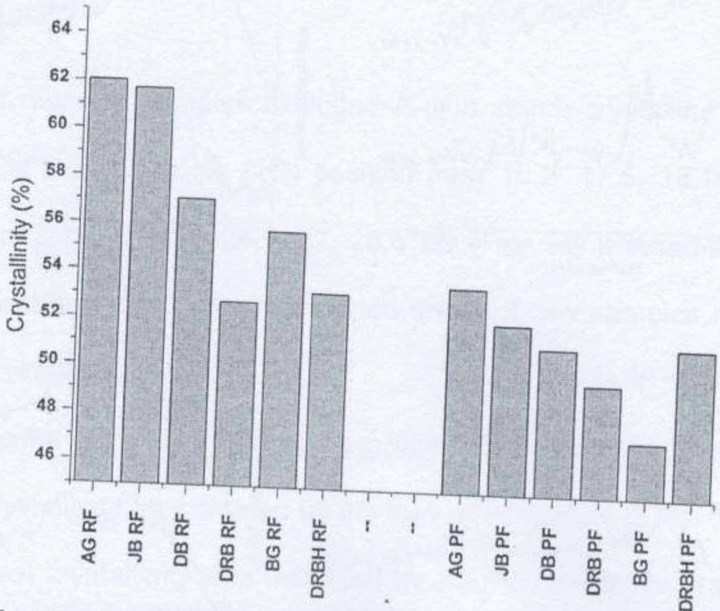


Fig 15 : Crystallinity values of raw rice and pitha flours.

SEM analysis

SEM images of raw rice flours with magnification 1000X and 4000X are presented in Fig. 16 and of pitha flours with magnification 1000X, 4000X and 5000X are presented in Fig. 17. The starch granules have polygonal shapes both in raw rice flours and the pitha flours. The raw rice flour had higher protein and fat content which may be present in complex formation due to which the starch granules are not clearly visible as separate granules in the raw rice flours. In all the pitha flours, the starch granules are seen adhering to each other and broken granules are also visible. This is probably due to swelling and partial gelatinization of the starch granules around the surface under high temperature and moisture (Lorlowhakarn et al., 2006). A clear view of slurry formation can also be seen in the SEM images with magnification 1000X in Fig.17 (pointed with black arrows) indicating gelatinized starch granules which can be correlated with the final moisture content of the pitha samples. Waxy rice is characterized to have low gelatinization temperature and the moisture available in the flour could gelatinize the rice flours during pitha preparation to a certain extent. DB showed less slurry formation as it has lowest moisture content out of all pitha samples. Pitha samples with higher moisture content showed smoother surfaces and the samples with rough surface were due to lower moisture content. (Lai et al., 1991).

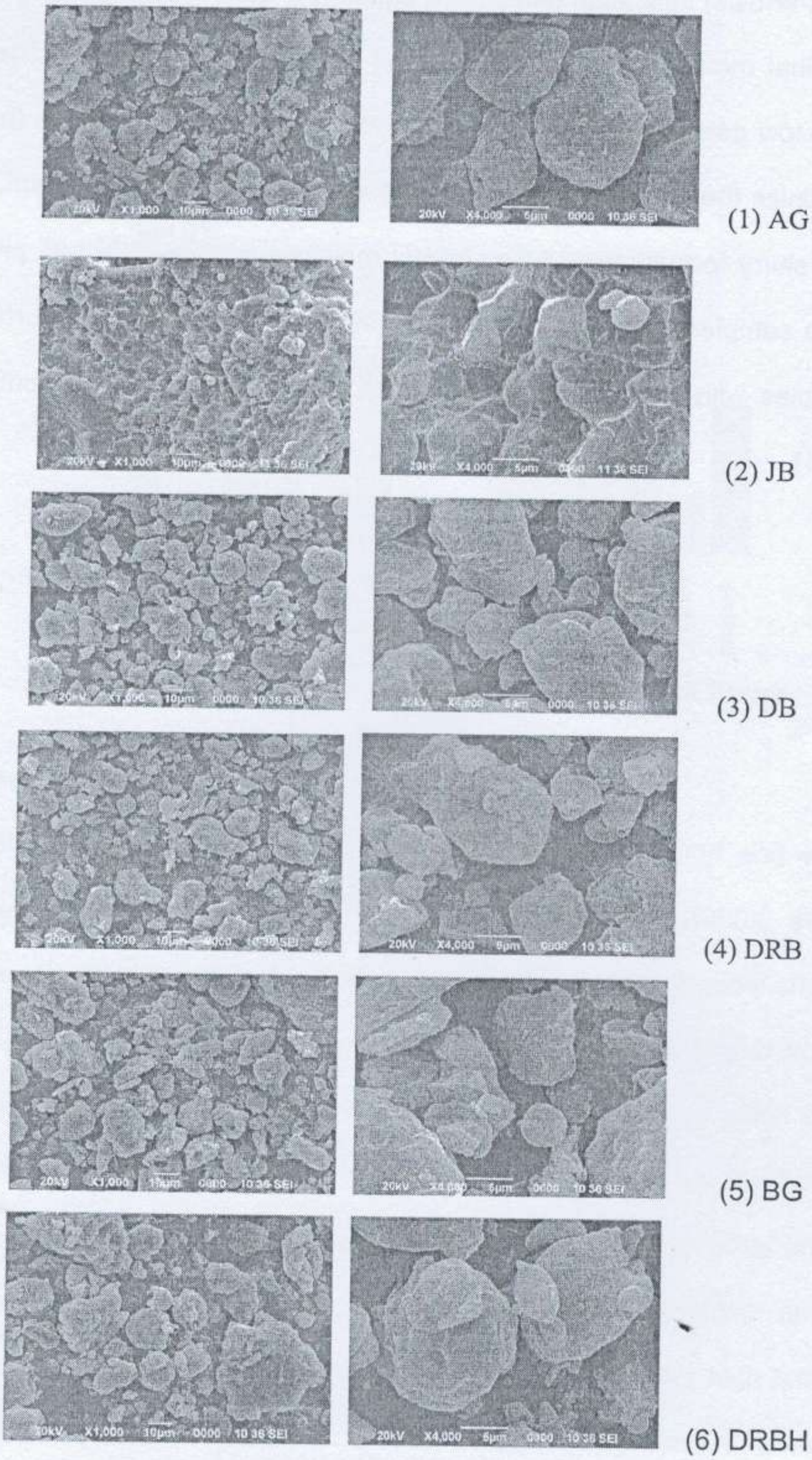
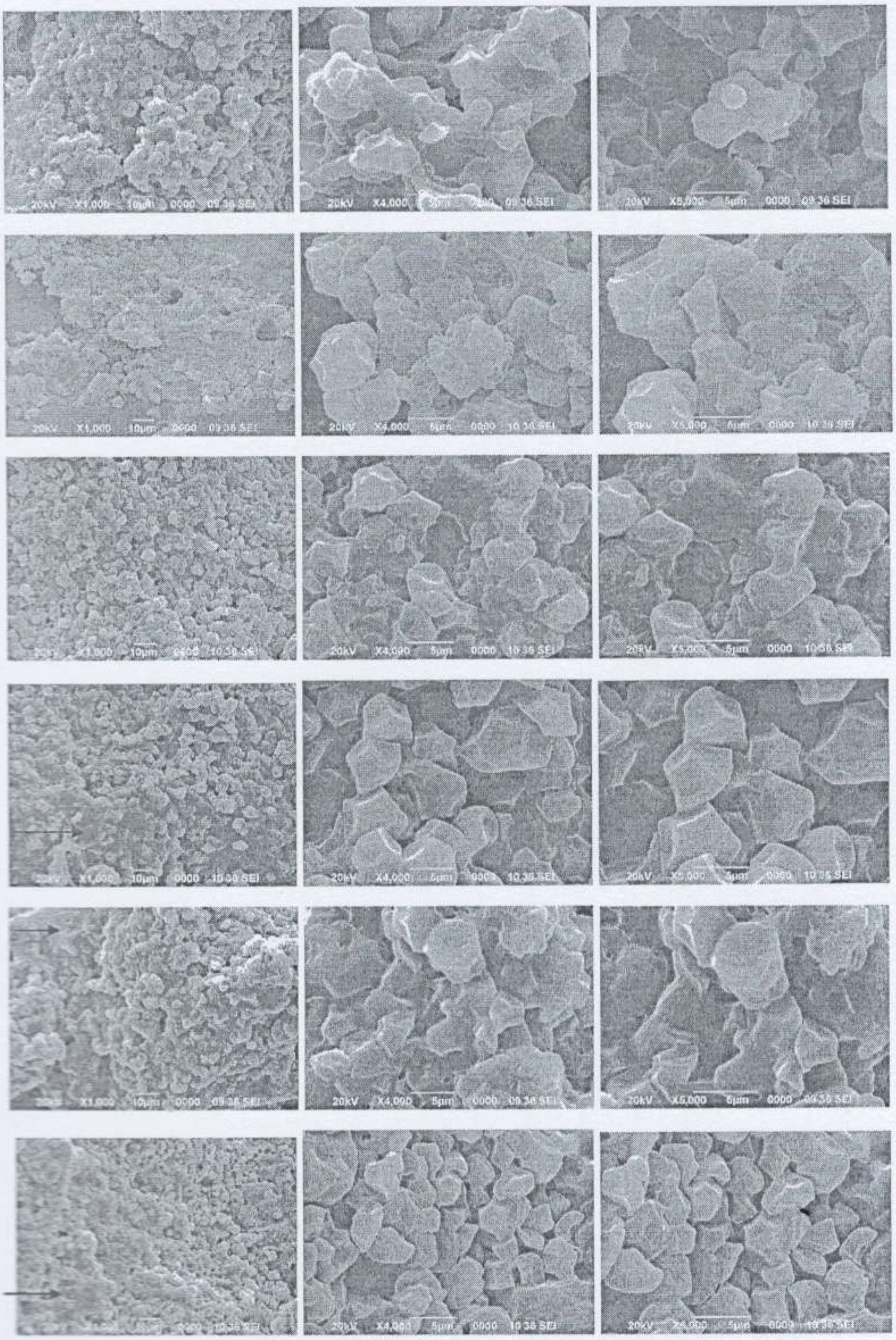


Fig. 16 : SEM images of raw rice flour



(1) AG
(2) JB
(3) DB
(4) DRB
(5) BG
(6) DRBH

Fig. 17 : SEM images of pitha flour

Results of the trial runs of machine (Local Varity Rice in Mysore):

Very fine particles were observed after grinding. The results after analysis of wet and dry particles are as shown below.

- **Wet Grinding**

Sl. No	Gap size (mm)	Particle size (µm)
1	0.4	5.41
2	0.3	5.21
3	0.2	4.92
4	0.1	4.79
5	<0.1	4.75

Uniformity of particle size - 70% (approx.)

- **Dry Grinding**

Sl. No	Gap size (mm)	Particle size (µm)
1	0.4	685.6
2	0.3	313.5
3	0.2	203.3
4	0.1	151.4
5	<0.1	95.29

Uniformity of particle size - 97% (approx.)

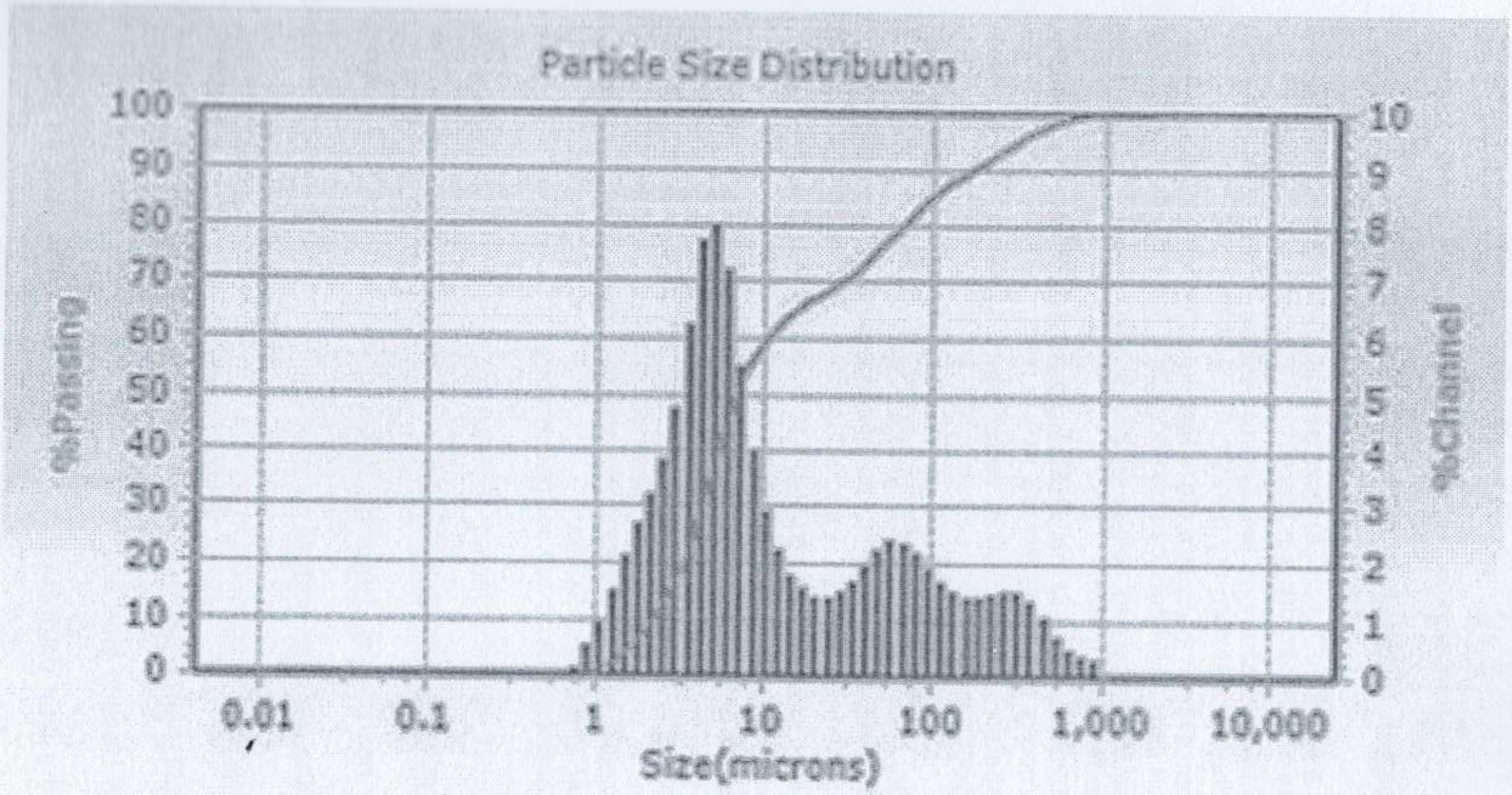


Fig. 18 : Particle size analysis

6.5 Advantages of the present invention.

- The process of wet cum dry grinding of food material is continuous.
- In the continuous wet cum dry grinder, the gap between the stationary and rotary silicon carbide wheels can be varied and variation in gap will result in uniform size for a given size.
- Grinding process has been divided in two parts, primary size reduction by primary cutter then secondary size reduction by silicon carbide wheels.
- Here primary cutter develops a negative pressure along the axis of rotation and thereby the feed material is sucked into the grinding zone continuously.
- We can save the time and energy by single pass grinding.
- The grinding operation can be started or stopped with a short notice.
- This grinder is useful for grinding of different varieties of grains like *Ragi, Rice, Wheat, Urdhal* and *Spices*.

7.0. Conclusion

The developed grinder was able to give moist powder from the fully hydrated waxy rice powder. However, more fine particle size of the powder is desired. The pitha prepared from all six varieties of waxy rice showed increase in amylose content while a decrease in protein and fat content was observed. The moisture content and amylose content showed major influence on the final product quality. Heating time and temperature during the pitha making process also affected the final product quality. Pasting properties showed drastic loss pasting points and also in the values of PV, HPV, FNV and BDN which is probably due to formation of amylose-lipid comple which in turn restricted granule swelling. Texture profile analysis strongly shows the more palatability and good product quality of pitha prepared from AG rice. Gumminess and chewiness were lowest in AG. XRD examination revealed decrease in crystallinity in all the pitha samples than raw rice samples. This indicated relative reduction in the mean inter-planar space of the crystalline region of starch. Morphological analysis of pitha flour indicated partial gelatinization of starch granules during the pitha making process which is attributed to the heating in presence of intermediate moisture.

Grinding is an important unit operation for size reduction. Machines for continuous wet grinding are not available. Accordingly the project was envisaged at CSIR – CFTRI in association with Tezpur university for design and development of wet cum dry grinding machine for grinding of waxy rice/ and other food grains. The machines developed under the project as described in this report have been thoroughly tested for the rated performance and endurance. The machine is covered by an IPR, patent number: 321/Del/2015. A process document has been submitted to process demonstration and research utilization cell (PDRUC) in CFTRI. The technology transfer fee of Rs 1,00,000 and a royalty of 0.25% on the sale price of the machine has been fixed by the PDRUC committee. The technology is ready for commercialization and the following industries have been contacted for commercializing the technology.

Sl No	Company Name	E-mail Address
1	AKSHAYA GRINDER	info@akshayagrinders.com
2	TTK PRESTIGE	ck@ttkprestige.com raj@ttkprestige.com
3	CROMPTON GREAVES LIMITED	Ravichandran.Kn@cgglobal.com, debkumar.dandapat@cgglobal.com
4	JYOTI MIXER	jaipan@jaipan.com
5	PHILIPS INDIA LIMITED	privacy@philips.com, corpcomm.india@philips.com
6	BUTTERFLY	gmal@butterflyindia.com
7	USHA	corporate@ushainternational.com
8	JAIPAN	jaipan@jaipan.com
9	SOGO	info@sogo.co.in, support@sogo.co.in
10	WARMEX HOME APPLIANCE	info@warmex4u.com, warmex@gmail.com
11	ANJALI KITCHEN WARE	feedback@anjalikitchenware.net
12	V-GUARD IN17DUSTRIES LTD.	mail@vguard.in
13	KOVAI LAKSHMI GRINDERS	contact@kovailakshmi.com
14	ANJALIMIX	info@anjalimix.com
15	ULTRA GRINDER	info@elgiultra.com
16	HAVELLS GRINDER	marketing@havells.cm ibd@havells.cm
17	SANTOSH | INDIA	vivek@santoshworld.com
18	PANASONIC GRINDER	helpline@in.panasonic.com.
19	KENSTAR	kenstar@vgmail.in
20	PIGEON	contact@pigeonestore.com
21	KELVINATOR	contact@videoconmail.com

8.0. Acknowledgement

The Principal Investigators and team thank the financial support of Department of Science and Technology (DST–IDP) for their encouragement in funding this research work. The team acknowledges the Director, CSIR – CFTRI, Vice chancellor of Tezpur University for the support and keen interest in the area of design and development of food processing machinery. Also thanks are to the Industrial partner in fabrication of the machines to the engineering drawings.

9.0 PROJECT ECONOMICS

Product: FORMING AND FRYING MACHINE FOR FOODS
Cost of the project FOR FABRICATION OF 3000 MACHINES PER ANNUM
Working: 300-days/ annum

A	**Land & site development**				
	Land area in Sq. M.		400		
	Land cost, land development cost, road formation, fencing etc				
	(@ Rs. per Sq. M.	250			**100000**
B	**Building & Civil work**				
	Building area in Sq. M.		200		
	Workshop and office (including architect's fees and contingency)				**800000**
	(@ Rs. per Sq. M.	4000			
	Others like overhead tanks, bore well & sump, elcretical installations				
C	**Plant and machinery**				
	a Total cost of P &M			885000	
	b Central Sales tax, freight, insurance & contingency (20 % on a)			177000	
	c Installation and Commissioning (10 % of a)			88500	
	Total Installed cost of plant and machinery (a+b+c)		**Total (C)**		**1150500**
D	**Auxiliary Equipments:**				
	a Lumpsum(Inspection tools Etc.)			50000	
	b Central Sales tax, freight, insurance & contingency (20 % on a)			10000	
	c Installation and Commissioning (10 % of a)			5000	
	Total Installed cost of plant and machinery (a+b+c)		**Total (D)**		**65000**
E	**Other fixed assets: office equipments, laboratory etc**				
	Office equipments, deposits				**50000**
F	**Pre-operative expenses**				
	Interest on investment at 14 % (on A+B+C) for 6 months			143535	
	Traveling expenses			20000	
	Start up cost			20000	
	Miscellaneous			10000	
	Technology transfer charges			10000	
			Total (F)		**203535**
G	**Total of (A+B+C+D+E+F)**				**2369035**
H	**Working capital margin**				**200000**
I	**Total project cost (G + H)**				**2569035**

Total security available (A+B+C+D+E):	**2043000**
Long-term loan @ 75 % of Total security:	**1532250**
Promoter's own share:	**1036785**
Short – term loan from bank for WC:	**200000**

Plant and Machinery

Sl.No	Brief specification & capacity	No. of units	Power kWh	Total no. o hours used	Total energy (kWhs)	Cost of equipment (Rs.)	Total Cost
	Principal plant and Machinery						
1	Machine shop consisting of basic units like lathe machine, drilling machines and assembly line	1	3	4	12	810000	810000
2	Welding facility with accessories	1	3	4	12	50000	50000
3	Sheet metal fabrication facility	1	0	2	0	25000	25000
	Grand Total	3	6	10	24	885000	885000

Working capital calculation (for 25 days)

Sl. No.	Components	Units	Qty./month	Month	Qty. Kg/ No.	Cost/Unit (Rs.)	Total cost	Loan component	Bank loan	Margin component	Margin Money
a	**Raw material**										
	1 SS shafts (assorted)	kg	100	1	100	250	25000				
	2 Electric motor	No.	250	1	250	2000	500000				
	3 SS Bolts & Nuts (assorted)	kg	10	1	10	200	2000				
	4 SS rods and others	kg	2500	1	2500	200	500000				
	5 SC Wheels	Nos	500	1	500	150	75000				
	6 Bearing seals Etc	Nos	500	1	500	120	60000				
	7 Electrials	Nos	250	1	250	40	10000				
						Total (a)	1172000	0.75	879000	0.25	293000
b	**Packing material**										
	1 Packing material	No.	250	1	250	25	6250				
						Total (b)	6250	0.75	4688	0.25	1562
c	**Factory expenses**										
	1 Staff-salary			1 month			71000	0	0	1	71000
	2 Utility			1 month			4594	0	0	1	4594
	3 Labour - wages			1 month			8000	0	0	1	8000
	4 Factory over heads			1 month			6440	0	0	1	6440
	5 Administrative expenses			1 month			2083	0	0	1	2083
	6 Financial expenses										
	LT Loan			1 month			17876	0	0	1	17876
	WC Loan			1 month			2333	0	0	1	2333
	7 Depreciation			1 month			13754	0	0	1	13754
	8 Merchandising expenses			1 month			8000	0	0	1	8000
						Total (c)	134080				
d	**Material in progress**			1 month			1178250	0.75	883688	0.25	294562
c	**Product in stock**			1 month	0	250000	0	0.75	0	0.25	0
f	**Bills recievable**			1 month	0	325000	0	0.9	0	0.1	0
	Total (a+b+c+d+e+f+)						2490580		1767376		723204

Staff Salaries & Wages

	Nos.	per month		
Administraion Staff				
1 Manager	1	30000	30000	
2 Assistant/ Accountant	0	8000	0	
3 Watch & Ward	1	8000	8000	
				38000
Production Staff				
1 Production Supervisor	1	15000	15000	
2 Mechanic/ Electrician	1	10000	10000	
2 Skilled workers	1	8000	8000	
	Total			**33000**
Labour				
1 Daily paid workers	1	8000	8000	
	Total			**8000**
Merchandising Staff				
1 Sales cum Service Engineer	1	8000	8000	
	Total			**8000**

Factory Overheads

1 Repairs & Maintanance			
@ 5.0% on plant & machinery		57525	
@ 2.0% on building		2000	
2 Insurance and taxes on building & plant & machinery @ 0.5%		6253	
3 Accessories spares for machinery & equipment @ 1%		11505	
	Total		**77283**

Utilitiy	**Units**	**days**	**Cost/unit/L**		
1 Electricity, KWh	24	300	7.5	54000	
2 Water, KL	0.5	300	7.5	1125	
		Total			**55125**

Administrative expenses Lumpsum			**25000**
Merchandising expenses	0	15000	**0**

Depreciation

1 On building @ 5.0% per annum		40000	
2 On plant & machinery @ 10.0% per annum		115050	
3 On auxillary items 10.0% per annum		5000	
4 On other fixed assets @ 10.0% per annum		5000	
	Total		**165050**

LT Loan Interest On 75% of the security available @ 14% per annum	**214515**
WC Loan Interest (14%) On short term WC Loan approximately Rs.200000	**28000**

Sl. No.	Calculation of Cost of production per annum Cost Components	Variable cost	Fixed cost	(Rs. in '000) Total cost
1	Raw material	11720	0	11720
2	Packing material	75	0	75
3	Utilities	55	0	55
4	Staff and workers salary/wages	96	852	948
5	Administrative expenses	0	25	25
6	Factory overheads	77	0	77
7	Financial expenses- LT loan interest	0	215	215
8	Financial expenses- WC loan interest	0	28	28
9	Depreciation	0	165	165
10	Merchandising expenses	0	96	96
	Total	12023	1381	13404

Average cost of production per unit (Rs.)	4468
Cost of selling 3000 machines at Rs. 5600 per unit	16800
Total selling price	16800
Contribution	4777
Break-even	28.91
Simple return on investment (profit + depreciation + interest on LT loan + interest on WC) *100/ (Total project cost including WC from bank)	137.38
Payback period on simple return on investment in year	0.73

FI/FE/DST/GAP-417/kvm

09.05.2016

Dr. Anita Aggarwal.
Scientist- "D",
Hall- "J", Cabin No.: "1",
Instrumentation Development Programme,
Technology Development & Transfer Division,
DST, MoST, Technology Bhavan, New Mehrauli Road,
New Delhi- 110 016.

Dear Madam.

Subject: Project entitled "Development of continuous wet cum dry grinder for grinding waxy rice for use in the state of Assam"- submission of final accounts and completion report reg.

Greetings from CSIR-CFTRI.

Enclosed is the completion report (three copies) along with the following documents as mentioned in letter by Ms. Rajni Rawat dated 10.03.2016.

1. Final UC/SU.
2. UC mentioning the balance amount after calculation of interest.
3. Share released by the industry and the necessary PO.
4. Letter from industries showing interest in adapting the technology (6 Nos).
5. Letter from head of institution - Director to retain one equipment in CFTRI.
6. Demand Draft bearing No. 365365 dated 20.04.2016 for Rs 1,75,727 as balance of project funds. (DD enclosed)

Please acknowledge the receipt of the completion report and the above documents.

K. Venkatesh Murthy
PI, GAP - 417

10/5/2016
(D. Kalita)
(Co-PI, Tezpur University)

Charu Lata Mahanta
10/5/2016
(C. L. Mahanta)
(PI, Tezpur University)

UTILIZATION CERTIFICATE (TWO COPIES)

FOR THE FINANCIAL YEAR 2015-2016

1. Title of the Project/ Scheme	Development of continuous wet cum dry grinder for grinding waxy rice for use in the state of Assam
2. Name of the Institution	Tezpur University
3. Principal Investigator	Prof. Charu Lata Mahanta
4. Deptt. of Science & Technology letter No. & date sanctioning the project	IDP/IND/2012/2(General) Date: 26/11/2012
5. Head of account as given in the original sanction letter	Non-recurring = NIL Recurring = ₹ 9,82,400/-
6. Amount brought forward from the previous financial year quoting DST letter No. and date in which the authority to carry forward the said amount was given	i Amount **₹ 1,49,777/-** ii Letter No. iii Date
7. Amount received during the financial year (Please give No. & date of DST's sanction letter for the amount)	i Amount ii Letter No. iii Date
8. Total amount that was available for expenditure (excluding commitments) Rs. during the financial year	**₹ 1,49,777/-**
9. Actual expenditure (excluding commitments) incurred during the financial year	**₹ 1,49,785/-**
10. Balance amount available at the end of the financial year	**(-) ₹ 8/-**
11. Unspent balance refunded if any (Please give details of cheque, Demand draft No. etc.)	None
12. Amount to be carried forward to the next financial year (if applicable)	NIL

UTILIZATION CERTIFICATE

Certified that out of **₹ NIL** of grants-in-aid sanctioned during the year 2015 in favour of Registrar, Tezpur University under the Department of Science & Technology Letter No. IDP/IND/2012/2(General), and **₹ 1,49,777/-** the unspent balance of previous year, a sum of **₹ 1,49,785/-** (Rupees One lakh forty nine thousand seven hundred eighty five only) has been utilized for the purpose of salary, equipments, consumables (excluding the commitments) for which it was sanctioned and excess expenditure of **₹ 8/-** was incurred.

Charu Lata Mahanta
10/12/2015
Signature of Principal Investigator with date
Principal Investigator
Dept. of Food Engg. & Tech.
Tezpur University
Tezpur -784 028, Assam

11.12.15
Signature of Registrar/ Accounts Officer
Finance Officer
Tezpur University

Signature of Head of the Institute
Registrar
Tezpur University

UTILIZATION CERTIFICATE (TWO COPIES)

FOR THE FINANCIAL YEAR 2015-2016

1. Title of the Project/ Scheme	Development of continuous wet cum dry grinder for grinding waxy rice for use in the state of Assam	
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Charu Lata Mahanta
10/12/2015
Signature of Principal Investigator with date
Principal Investigator
Dept. of Food Engg. & Tech.
Tezpur University
Tezpur -784 028, Assam

11.12.15
Signature of Registrar/ Accounts Officer
Finance Officer
Tezpur University

Signature of Head of the Institute
Registrar
Tezpur University

Consolidated Statement of Expenditure (8.00 Lakhs)

Sr. No	Sanction Heads (I)	Funds Allocated (sanctioned (II)		Fund (instalment) recd (₹) (III)		Interest earned (₹)		Expenditure (₹) (IV)				Total Expenditure (₹) (V)	Balance as on 3/2/2015 (₹) (II-V)
		1st yr	2nd yr	1st	2nd	2nd yr	3rd yr	11/9/2012 - 31/03/2013	1/4/2013 - 31/3//2014	1/4/2014 - 31/3//2015	2015 - 2016		
1	Manpower costs	2,11,200	2,11,200	₹ 5,00,000/-	₹ 3,00,000/-	₹ 5,520/-	₹ 2,771/-	8,000	1,85,228	1,57,420	NIL	3,50,648	NIL
2	Consumables	1,50,000	1,00,000					NIL	1,50,000	17,164	89,542	2,56,706	NIL
3	Travel	75,000	75,000					NIL	7,273	57,581	NIL	64,854	NIL
4	Contingencies	50,000	50,000					NIL	53,348	NIL	35,874	89,222	NIL
5	Others, if any	NIL	NIL					NIL	NIL	NIL	NIL	NIL	NIL
6	Equipments	NIL	NIL					NIL	NIL	NIL	NIL	NIL	NIL
7	Overhead expenses	30,000	30,000					NIL	22,500	NIL	24,369	46,869	NIL
8	**Total (₹)**	**5,16,200**	**4,66,200**					**8,000**	**4,18,349**	**2,32,165**	**1,49,785**	**8,08,299**	NIL

Fund allocated : ₹ 9,82,400

Fund Released : ₹ 8,00,000/-

Interest earned : ₹ 8291/-

Total : ₹ 8,08,291/-

Fund Utilized : ₹ 8,08,299/-

Balance (-) : ₹ 8/-

Charu Lata Mahanta
Name and signature of Principal Investigator
Date: 4/12/2015
Principal Investigator
Dept. of Food Engg. & Tech.
Tezpur University
Tezpur -784 028, Assam

B [signature] 11.12.15
Signature of Competent financial authority (with seal)
Date:
Finance Officer
Tezpur University