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Alkaline Extraction of Starch from Broken Rice of Pakistan

Muhammad Usman[1], M. Tahir Ishfaq[2], Dr. Shahid Raza Malik[2], Muhammad Iqbal[3], and Bushra Ishfaq[4]

[1]Production Department,
Rafhan Maize Products Co. LTD (INGREDION, USA),
Faisalabad, Pakistan

[2]Chemical Engineering Department,
NFC Institute of Engineering and Fertilizer Research,
Faisalabad, Pakistan

[3]Oilseeds Research Institute,
Ayub Agriculture Research Institute,
Faisalabad, Pakistan

[4]Food Technology Section, Postharvest Research Center,
Ayub Agriculture Research Institute,
Faisalabad, Pakistan

ABSTRACT: Six types of broken rice were chosen such as KSK-133, Basmati-86, Basmati Super, Kaynaat, IRRI-6, KS-282 then after the market survey, got its prices and also got its initial compositions of starch then one type of broken rice KSK-133 was selected due to economical point of view because its initial composition of starch was 70.3% and its price was 34 rupees per kilogram. The low quality rice processed to produce the rice starch. The production process of the rice starch from low quality rice KSK-133 investigated. The starch extracted from rice by alkaline extraction technique. The main objective is to obtain high starch content from KSK-133 and compare with starch content of other two types which are even more economical such as IRRI-6 and KS-282 at best extraction condition of KSK-133. The independent variables are types of broken rice. In a steeping process, used distilled water with grinded flour sample of rice and set the operating conditions. 0.1M caustic soda solution was used for set the test pH. Maximum rice starch has been recovered up to 95.4% from KSK-133. In comparison of starch content with other two types, KSK-133 starch content 89.95%, IRRI-6 starch content 86.64% and KS-282 starch content 87.52% has been achieved at best extraction condition.

KEYWORDS: Alkaline Extraction, Pakistani Rice, Recovery of Starch, Broken Rice, Economical Types of Rice

1 INTRODUCTION

Starch is a central component of human diet and it is acquired from different sources such as wheat, maize, rice, potato etc. [1]. Potato and tapioca are high in starch but contain very high moisture. Due to which their storage is extremely expensive. In food industry, it is used in different products such as starch hydrolysates, glucose syrups, fructose, maltodextrin derivatives or cyclodextrins by means of chemical and enzymatically processing. It is a polymer of glucose and consists of two type glucose polymers such as amylose and amylopectin [2], [3]. These polymers have different structures and properties. Polymers of starch are linked with each other through the glycosidic bond. Particle sizes range from 2-100 micrometer [4]. The starch granules are dense and insoluble in cold water. In order to dissolve the starch granule, heat has to be applied. Rice is a staple food for a large part of the world's population, especially in Asia and the West Indies [5]. Due to economic reasons the rice starch is extracted preferably from broken rice which is most valuable for numerous industries like food and cosmetic industry [6]. It is also demanding because of its unusual characteristics like small particle size, white color and neutral taste. The rice starch is primarily valuable for starch processing industry. There are several methods for producing rice-starch. They are alkaline-steeping method [7] high-intensity ultrasound and surfactant [8], [9] Guraya method [10], protease digestion [11], [12] and alkaline-protease methods [13]. These methods show different characteristic and also shows different extraction efficiencies and functional properties. The alkaline steeping-method [7] is the simplest method for starch production. This method is applied easily in a simple apparatus system. The advantage of this method is high purity of produced starch. At ideal extraction conditions, extracted components have little or negligible structural changes. In starch, depolymerization or change (damage) to its crystalline phase is detrimental the detail mechanism of rice protein extraction into alkaline solution has not yet been clearly defined. The mechanism is probably based on the protein solubilization in the alkaline solution without chemical changes. The extraction process continues and stops when the equilibrium is reached. This assumption is based on the protein extraction process in the animal tissue [14]. The soluble protein can be isolated effectively. Alkaline solutions are generally employed for isolation of rice starch, because high portions of rice protein consist of alkali-soluble and high molecular weight glutelins.

The present study is carried out to enhance the good recovery of starch. The different types of Pakistani broken rice were directly obtained from the market and milled in the dry condition without any treatment. The produced starch has the quality as good as the available commercial rice starch. There is dire need in our country to focus on the other crops for the extraction of starch rather than maize which will be helpful to meet the demands of industries and economical.

2 MATERIALS AND METHODS

2.1 PROCUREMENT OF RAW MATERIALS

Six types of broken rice were procured from Rice Research Institute Kala Shah Kako Lahore Pakistan such as KSK-133, Basmati-86, Basmati Super, Kaynaat, IRRI-6 and KS-282.

2.2 PROXIMATE ANALYSIS

Preliminary trails were conducted to determine the proximate composition of different types of Pakistani broken rice.

2.3 STARCH EXTRACTION

The whole process involves for starch extraction is depicted from fig.1 (1) grinding (2) mixing of rice flour with alkaline solution (3) digesting of the protein, (4) primary filtration, (5) washing with water, (6) Vacuum filtration (7) drying the starch cake. The production apparatus were grinder, steep, 325 mesh screen, vacuum flask, beaker, filtration cup, filter paper, pH meter and thermometer. Firstly took the rice sample, and then grinded the rice with the help of grinder. Steeping solution prepared in a steep. Here took the grinded rice flour sample with distilled water. Then set the pH by using the 0.1M caustic soda solutions. During washing kept the flour to water ratio 1:3 while during extraction it was 1:10. From protection of bacteria and its growth used 0.01% sodium metabisulphite weight to volume ratio. The steep solution was continually circulated. For this purpose, steep's pump was operated at 2800 rpm for 22 hrs.

For the protein recovery, the peak lipid film was removed from the surface. Un-bonded protein was separated with the help of water. After every two hours the pH of the steep solution was checked and set to the test pH with the help of 0.01M caustic solutions.

Primary filtration was done after every two hours. For primary filtration, 325 mesh screen was used and this step was called primary filtration. Then steep solution was poured on the screen, the tiny particles passed from screen. Then over size particles again sent back to the steep for further recovery of starch. But test conditions were kept same.

The extracted starch was collected and given residence time for 90 min. in a beaker. The separated residue was collected and recycled in a steep. The recovered starch was again washed with water in the ratio of 1:3 respectively. At this time all the remaining residue was separated for protein recovery. The separated starch was isolated onto a filter paper. Then this filter paper was fixed on a vacuum flask for vacuum filtration for removal of water. This step was called vacuum filtration. All the partially wet recovered starch was collected on the filter paper. Then it was kept in atmosphere for air-dried at room temperature for 48 hrs.

Then dried starch weight was measured. This weight was compared with the initial weight of starch which was present in the rice and calculated the starch recovery (%).

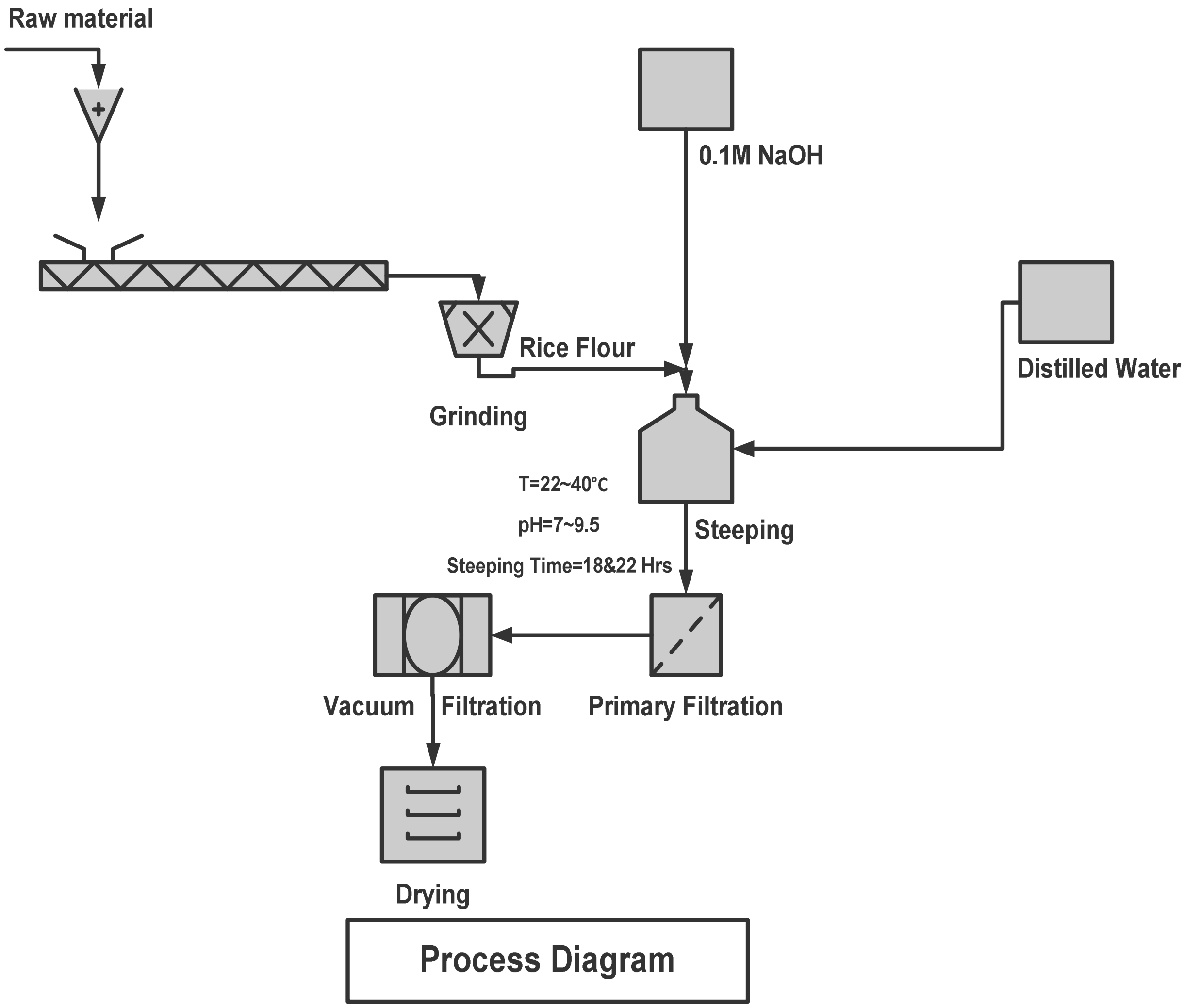

Figure-1: Process Flow Sheet

3 Results and Discussion

Initially compositions were found. A market survey was also conducted, to get the prices of all chosen types then selected the economical type.

Table 1 Economical Comparison of Different Types of Rice

Types Of Broken Rice	Price (Rs.)/Kg	Moisture (%)	Protein (%)	Initial Starch (%)
*KSK- 133	*34	12.80	5.60	*70.30
Basmati-86	40	13.60	5.70	67.30
Basmati Super	44	13.00	6.70	70.0
Kaynaat	70	11.50	6.30	65.60
IRRI-6	36	13.50	6.20	68.60
KS-282	40	12.70	5.80	68.20

After the economical comparison the KSK-133 which was the most feasible and economical type because it has a highly initial starch % and also has a low price. On the basis of preliminary trials conducted on proximate composition like moisture, protein%, and starch%. The rice variety was selected for further analysis.

Table-2: Starch Recovery %age at Different pH and Temperatures

Sr. No.	Temp (^{o}C)	22	25	30	35	40
	pH	Starch Recovery (%)				
1	7.0	73.60	74.20	75.20	75	80.95
2	8.0	86.10	87.13	88.85	89.85	92.15
3	8.5	88.15	88.50	89.10	89.95	93.15
4	9.0	88.25	88.79	89.70	90.25	93.30
5	9.5	89.50	89.66	89.95	92.90	95.40

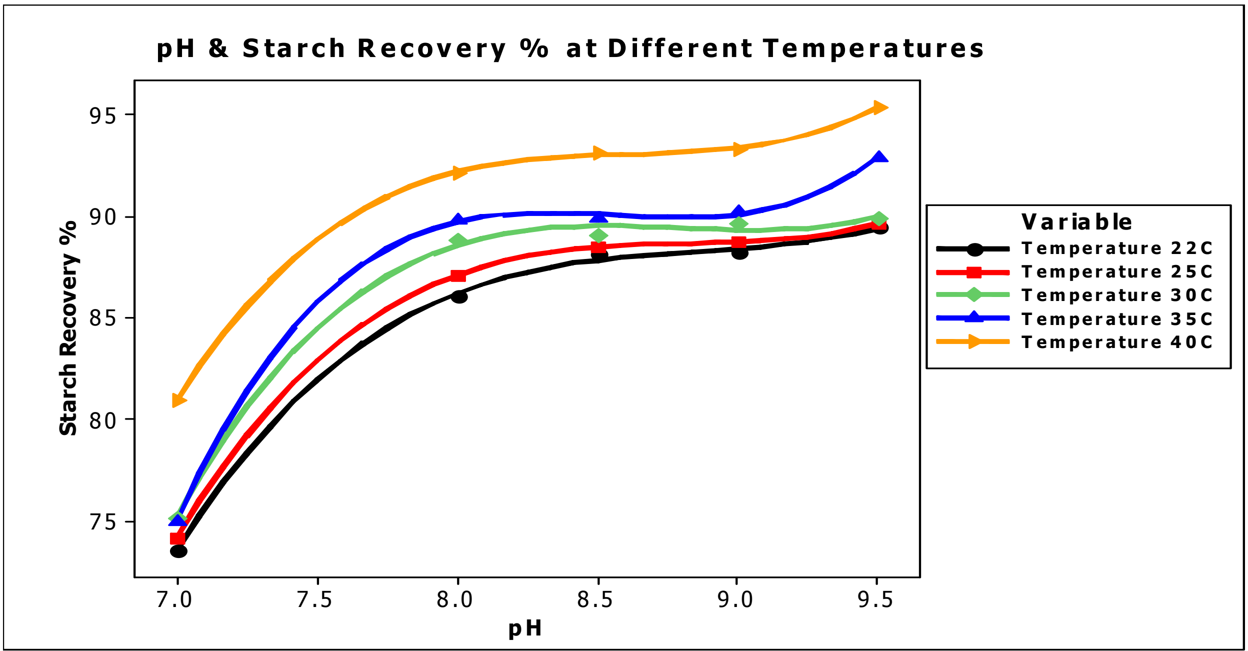

Figure-2: pH & Starch Recovery % at Different Temperatures

Fig.2 depicted that if we compared all the graphical lines then it is cleared that the maximum starch recovery has been achieved 95.4% at 9.5pH and at 40^{o}C. The minimum starch recovery has been achieved 73.6% at 7pH and at 22^{o}C. This showed that temperature was kept constant and pH changed. The pH and temperature are directly proportional with each other.

The protein content is the second response variable to determine the quality of the rice starch. The protein content must be kept as low as possible to meet the specification of high quality rice starch. High content of protein could spoil the sticky and gristly characteristic of the rice starch.

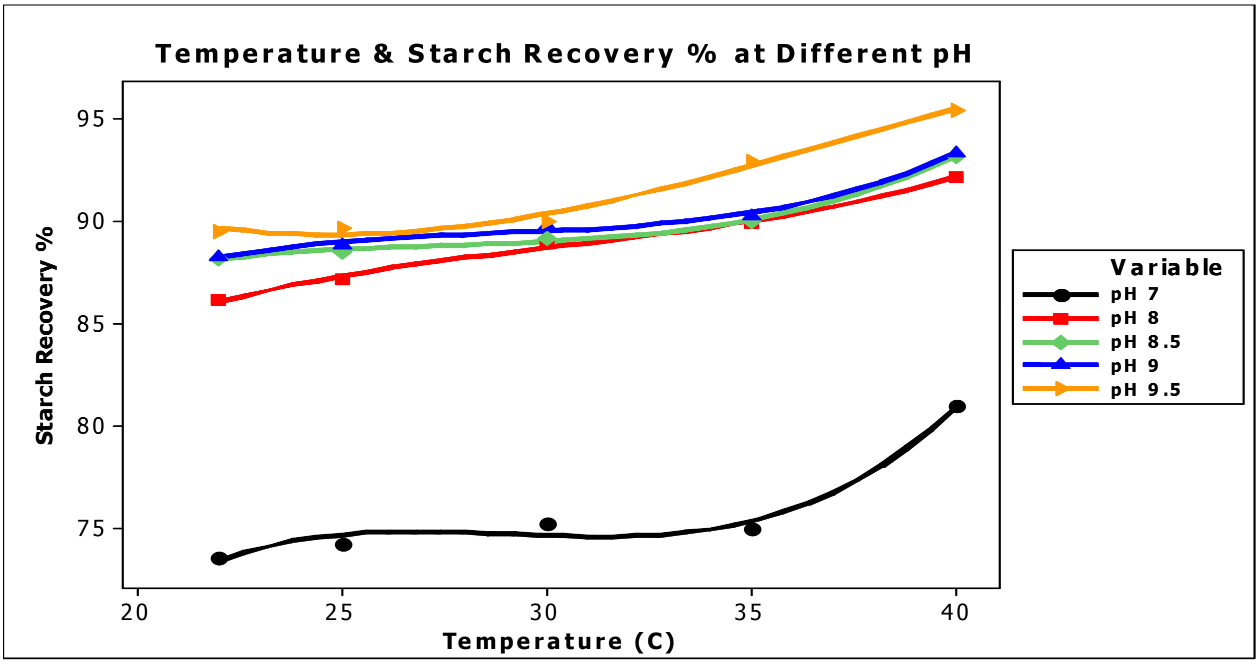

Figure-3: Temperature & Starch Recovery % at different pHs

From fig.3 it was concluded that extraction temperature did not affect the residual protein content when the extraction temperature was higher than 25°C although the difference between 20°C and 25°C was significant. The adverse effect by raising the extraction temperature might be associated with changes in starch structure which are induced by heat and alkali.

The alkaline conditions could leads to undesirable protein modification as well as molecular cross linkage and rearrangements resulting in the formation of toxic compound. On the other side at the high temperature starch gelatinization is started.

The quality of produced starch is indicated by higher starch content. The starch content increases with temperature and pH. The maximum starch recovery and extracted starch weight has been achieved 95.4% and 67.07gm respectively at 40°C and 9.5pH.

Optimum condition is determined by the variables. The optimization objective is to have the starch content as high as possible with good quality. According to the data obtained above, the optimum condition to produce a high quality rice starch from the raw material of low quality rice with the alkaline method at 35°C and at 8.5pH.

3.1 Comparison of Different Types of Broken Rice at Best Extraction Conditions IN PRESENT WORK

After performed the experiment, two more types of broken rice selected which is less economical than KSK-133 and performed the experiment to found the recovery percentage at best extraction conditions. There is several research results reported in the literatures about the rice starch production for different types. Each of them gives different results. These differences are caused by some factors, such as starch content, protein content, moisture content and others.

Table-3: Comparison of different types of broken rice at best extraction conditions

Broken Rice	Initial Starch (%)	Amount Of Rice (gm)	Temperature (°C)	pH	Steeping Time (Hrs)	Amount of Starch On D.B (gm)	Starch Recovery (%)
KSK-133	70.3	100	35	8.5	22	63.23	89.95
IRRI-6	68.6	100	35	8.5	22	59.44	86.64
KS-282	68.2	100	35	8.5	22	59.69	87.52

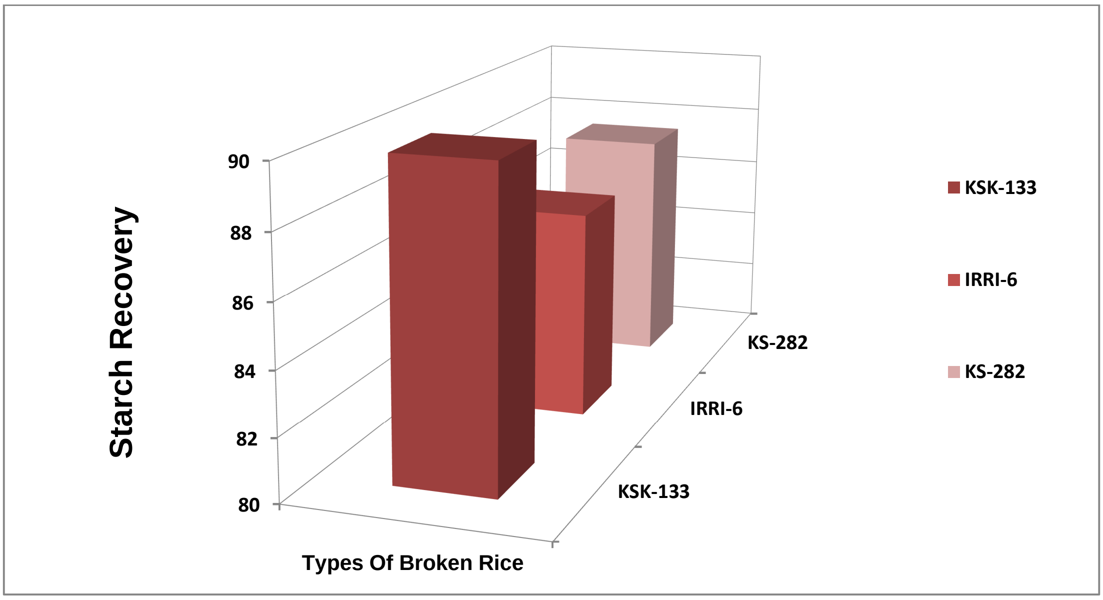

Figure-4: Types of Broken Rice & Starch Recovery %age

From fig.4 it is cleared that KSK-133 given the maximum starch recovery rather than the other two types. KSK-133 starch content 89.95%, IRRI-6 starch content 86.64% and KS-282 starch content 87.52% has been achieved at best extraction condition.

The produced starch in this work contains 95.4% starch contents. This result is higher by comparing to other research work. The variation in results may be caused by the difference of material and with no pretreatment of rice. The present work uses broken rice that contains higher protein and moisture contents and impurities while other researchers used selected and pretreated rice. High quality rice's color is bright white. This is a sign that it contains less protein than the broken and low quality rice.

Bindar, Efan and Rahim [15] extract starch from low quality rice IR64 grade 3 which contained 89.72% starch contents. They kept the steeping time 7 hours and used enzyme, but in this work Pakistani broken rice used such as KSK-133 and kept the steeping time 22 hours and only used the NaOH instead of NaOH and enzyme digestion technique and extract 95.4% starch content. This makes the process economical and in alkaline extraction digestion method used the enzyme increased the cost of process and made it expensive.

4 Conclusions

It is concluded that alkaline method was successfully implemented to produce the better quality rice starch from broken rice KSK-133. High portion of rice protein is easily soluble in alkaline solution. Alkaline method has a good recovery and low residual protein content due to high molecular weight glutelins. Maximum recovery of starch from KSK-133 rice has been achieved up to 95.4%. In comparison of starch content with other two types, KSK-133 starch content 89.95%, IRRI-6 starch content 86.64% and KS-282 starch content 87.52% has been achieved at best extraction condition. Further improvements are needed to produce high quality rice starch that meets the international starch standard. The future research should emphasize on using different enzymes.

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