SYNOPSIS

The thesis has been presented in the following Chapters :

Chapter I It gives an introduction to the process of parboiling of paddy with reference to its objectives and principle. A review of literature on the mechanism of absorption of water by the grain along with mathematical analysis, and subsequent gelatinization of starch granules has also been incorporated.

Parboiling is a process of moisture-heat treatment of paddy and is followed by soaking in water and subsequent steaming and drying before milling in the usual way. The primary change brought about during soaking and particularly during steaming, is some sort of chemical reaction, called gelatinization. This changes the structure of rice kernel by hydration and irreversible swelling of starch granules. Gelatinization and some other secondary processes occurring during parboiling, bring about many improvements in the quality of finished rice. While the process of soaking and subsequent steaming supply adequate moisture and heat requirements for complete parboiling, another possibility is that mere soaking in water at elevated temperature may fulfil these requirements also.

The reported literature[1-3] indicated little studies on the mechanism of absorption of water by paddy. Following a detailed study

on the absorption of water by wheat kernel[4], earlier workers[1,2] observed that the basic process of absorption of water by paddy during soaking is diffusion. They also assumed that the integral diffusion equation, developed by Becker for unsteady-state diffusion in solids of arbitrary shape[5], describes the absorption of water molecules into paddy. The equation, in the neighbourhood of time zero, is of the general form :

$$1 - \bar{M} = \frac{2}{\sqrt{\pi}} X + BX^2 \qquad .. (1)$$

where $\bar{M} \equiv \frac{x_s - \bar{x}}{x_s - x_o}$, $X \equiv \frac{S}{V}\sqrt{D\theta}$

(The notations m and t in the original equation have been changed to x and θ respectively).

Neglecting higher power of X, Eq. (1) becomes on rearrangement

$$\bar{x} - x_o = \frac{2}{\sqrt{\pi}} (x_s - x_o) \left(\frac{S}{V}\right) \sqrt{D\theta}, \qquad ..(2)$$

$$\bar{x} - x_o = k_m \sqrt{\theta}, \qquad ..(3)$$

where $$k_m = \frac{2}{\sqrt{\pi}} (x_s - x_o) \left(\frac{S}{V}\right) \sqrt{D} \qquad ..(4)$$

The analysis of the data of earlier workers[1-3], based on Eq.(3), showed little uniformity in the approach to the problem of diffusion during soaking of paddy and the values of the constants so calculated were not comparable with each other. Regarding gelatinization of grains during soaking, no attempt has been made so far as to evolve a method of measurement of degree of parboiling and to give a quantitative picture of the progress of gelatinization during soaking.

This investigation was, therefore, taken up to study the soaking characteristics of some varieties of paddy with the following objectives:

(i) to give a better and more uniform picture on diffusion of water molecules inside the grain and subsequent gelatinization of starch granules;

(ii) to give a generalized correlation of the data on soaking of various investigators; and

(iii) to evolve a method for evaluation of degree of parboiling.

Chapter II This chapter incorporates detailed information on materials and experimental procedures. The following five high-yielding varieties of paddy have been used in the investigation :

TABLE

Sl. No.	Variety	Length, mm.	Mean diameter, mm. $\frac{(\text{Breadth}+\text{thickness})}{2}$	Storage time
1.	JAYA	9.02	2.51	6 months or more
2.	RATNA	9.24	2.17	"
3.	PADMA	7.62	2.46	"
4.	BALA	7.01	2.52	"
5.	PANKAJ	8.58	2.57	"

Variables studied for moisture gain, swelling and degree of parboiling are as follows :

1. Temperature, ^{o}C : room temperature(28-30), 40, 50, 60, 65, 70, 75, 80.
2. Time : 10 min to 12 hrs. and upto about 28 hrs. in case of room temp.

The experimental techniques for measurement of moisture gain and swelling were based on Ghose et al.[1] The degree of parboiling was measured from the percentage of grains completely gelatinized,i.e., from percentage of grains without "opaque spot". The "opaque spot" was observed in a number of soaked grains after cutting the grains into two halves with a sharp edge.

Chapter III. The results of investigation have been presented in this chapter in the following way :

(i) Moisture content history of all the varieties at different temperatures.

(ii) Swelling or volume gain in part/part initial volume,as a function of time and temperature of soaking for varieties JAYA, PADMA, BALA and PANKAJ.

(iii) Degree of parboiling as a function of time and temperature of soaking for all the varieties.

Chapter IV. This chapter includes analysis of the results presented in Chapter III.

Chapter V. The important findings and conclusions of the investigation have been presented in this chapter as listed below :

1. The data on moisture gain can be adequately correlated by the diffusion equation, Eq.(3), for all the varieties of paddy in the temperature range studied. However, the equation is valid for a short duration of soaking and upto a limiting moisture content which is attained by the grains either just before reaching a point of equilibrium below a temperature of 60-65^{o}C or at the onset of rapid hydration above 60-65^{o}C.

2. The Arrhenius plot of diffusion coefficient for all the varieties exhibits[6] a break around a temperature of 70^{o}C. Similar observation[7] has also been noted with the data of other workers. This phenomenon has been explained by considering two different mechanisms predominant in the two different temperature regions. Larger values of activation energy above the temperature of break correspond to gelatinization of starch granules which is predominantly a chemical process. The temperature of break is very close to gelatinization temperature of rice starch granules. The results on swelling and degree of parboiling of grains have confirmed this finding.

3. Another important finding of this investigation is that adequate degree of parboiling is achieved at a moisture content of about 0.55 g./g. dry basis by soaking alone near about gelatinization temperature. This confirms the findings of Ali[3].

4. The soaking data on different varieties of paddy collected by various workers have been presented by a single semi-empirical correlation with fair measure of accuracy. This gives an unified approach to problem of moisture diffusion in paddy during soaking.

Nomenclature :

x_o	initial, uniform moisture content, g./g. dry basis.
$\bar{x}$	average moisture content at given absorption time, g./g. dry basis.
x_s	effective surface moisture content at times greater than zero, g./g. dry basis.
θ	absorption time, sec.
(S/V)	surface-to-volume ratio of a solid
D	diffusion coefficient, $cm^2/sec.$
B	dimensionless constant.

References :

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