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**TECHNOLOGICAL STUDIES
FOR PRODUCTION OF EASY COOK
PARBOILED CARGO RICE**

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BY

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DEDICATION

To the blessed God and the honoured spirit of my deceased father, mother and my elder brother Prof. Dr. Farouk Ibrahim Gab-Alla, who I consider as a father, professor, promotive and my supporter in achieving my targets - I dedicate my thesis, not forgetting his family's assistance.

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INTRODUCTION

Rice (*Oryza sativa* L.) is one of the oldest and important food crop for human been all over the world. In some countries rice provides 80 % of the nutrition requirements, About 73 % of the rice production in USA is used as a human food, 7 % for seed and 20 % for industrial purposes, whereas in Japan 92 % consumed as a main food supply (Kent 1975).

In Egypt, rice is considered to be the 2nd important crop for exporting after cotton. * The average cultivated area of rice in Egypt during the last five years reached 1203077 Faddan, with an average paddy grain production of 3.20 ton / fad.

Farmers in Egypt, in the recent years prefer to cultivate rice than the other summer crops because of its higher economic net return from the area, but the limiting factor in increasing its area here is the water supply and high water consumption of rice as compared with other summer crops.

Therefore, to meet the gradual increase in rice consumption in developing countries, which have a rapid increase in population the high yielding varieties must be replaces the traditional and local varieties of low productivity. In Egypt, we planted high yield varieties such as IR. 28, Giza 171, 172 and Giza 181, but some of these high yield varieties have some technological defects during milling and whitening processes. This leads to great losses of substantial part of the grain yield.

*After the Statistical and Agricultural Economic Res. Instit., Agric. Res. Center, Egypt, 1996.

Accordingly, using methods to obtain high milled rice yield with a good technological, chemical, nutritional and cooking properties becomes an important objective in rice production.

The term parboiling of rice grains (boiling or over heating, hydrothermic treatments) covers the operations to which the paddy is subjected before milling. The main elements in parboiling process are water, heat and sometimes hydrostatic pressure, and that can be achieved by soaking and steaming processes. The grains after boiling must be dried immediately before milling.

Rice parboiling is a widely accepted practices in South East Asia and some countries of Africa. The major objectives of parboiling rice today are to :

1. Increase the total and head yield of paddy .
2. Decrease broken and increase rice hardness during milling.
3. Prevent the nutrients losses during milling.
4. Vitamins and minerals move towards the inner position of the grains, where as lipids and protein redistributed in the grain.
5. Drying will reduce the moisture content to optimum levels.
6. The starch grain embedded in a proteinaceous matrix, constituting the endosperm mass, swell and expanded until they fill up all the air spaces.
7. The orderly polyhedral structure characters of starch, is replaced by a homogeneous and compact mass of gelatinized starch.

8. Finally, prepare the rice according to the consumers requirements. (gariboldi, 1974 ; Sesay and Verma, 1985 ; Abou-Gharbia, 1989 Damir, 1991 ; Biliaderis *et al.*, 1993 ; Marshall *et al.*, 1993 and sowbhagya *et al.*, 1994).

Recently, as a results of increasing the cultivated area from the long grain varieties in Egypt, parboiling the paddy rice became an important concern for white rice utilization and increasing the milled rice yield.

Methods and treatment of parboiling rice differed from country to another, according to the rice varieties used, the objectives of parboiling process, costs of the operations, the technological developments of the country, equipments used in parboiling and the consumers habits.

In Egypt, different parboiling treatments were studied in order to optimizing the procedures of parboiling or maximizing the white rice yield (Damir 1985, Abou-Gharbia 1989, EL-Akary 1992 and Abou-Zaid 1993).

AIM OF INVESTIGATION

1. Produce parboiled cargo rice easy cooked with high nutrition value and rich in vitamins.
2. Optimizing the drying level under the different temperature and its effect on cooking time.
3. Possibility of decreasing the cooking time by using a diluted solution of sodium bicarbonate.
4. Previous prediction of the cooking time from the drying degree used after parboiling.
5. studying the panel taste on the new product (parboiled cargo rice) to show the extent of its pleasurability (colour, taste and overall acceptability).
6. Evaluating the physical, technological and chemical properties of the parboiled cargo rice resulted, as compared with the white rice of the same variety used in consumption.

REVIEW OF LITERATURE

The technological studies for production of easy cook parboiled cargo rice will be reviewed under the following main headings.

- I . Parboiling procedures and drying.
- II . Physical and technological properties of rice.
- III . Chemical analysis.
- IV . Scanning electron microscopy of rice.
- V . Cooking quality.
- VI. Panel test.

I . Parboiling procedures and drying :

Bhattacharya and Rao (1966), practiced soaking process for paddy rice at room temperature, 50, 60, 70, 75°C for 2 hrs, then 65°C and at 80°C with three levels of time for each temperature degree. The time and pressure of steaming were also varied, then rice grains subjected to shade, sun and mechanical drying. They studied the effect of parboiling treatments on moisture content and milling yield.

Dimopoulos and Muller (1972), studied the effect of steeping rice grains in water at 64°C for 3.5 hrs, 5.5 hrs, 6.0 hrs and 7.5 hrs and samples with the same steeping time were steamed simultaneously at 10.0 P.S.I., then dried in the absence of direct sunlight to avoid any stress in kernels. Protein content and some physicochemical properties of parboiled rice were studied.

Runte (1972), determined the parboiling effects on paddy and cargo rice. Processing variables included : steeping at 60 - 75°C for 150 min, and gelatinizing at 95°C for 5 - min. Application of hot water, soaking and

pressurized gelatinizing reduced the processing time for parboiling (excluding drying) from 3 - days to 2.5 - hrs.

El-Gindy *et al.* (1973), examined the parboiling effects on the milling quality of two rice varieties. Parboiling involved soaking grains in distilled water at 30°C for 0, 12 or 24 hrs, and at 40°C for 0, 4, 5 or 6 hrs, followed by steaming at pressures of 0.5 ,1.0 and 1.5 kg / cm². The parboiled grains were dried at 30°C to 12 - 12.5 % moisture and milled.

Padua and Julianio (1974), indicated that parboiling consists of steaming presoaked rough rice (by hot water) and drying it to accelerate aging of freshly harvested rice. They soaked rough rice for 6 - hrs at 60°C, and steamed it after water drained for 20 min, at 100°C or 10 - min for 121°C and air-dried at room temperature. They concluded that the changes in the rice grain caused by parboiling are mainly physical rather than chemical.

Shivanna (1974) and (1976), found that pressure parboiling method reduced processing time and higher milling yield was obtained. In the hot soaking method he used hot water at 70 - 75°C for 3.5 hrs, with paddy rice (14 - 16 % moisture content).

Bakshi and singh (1980), soaked rough rice in hot water at 50 -120°C range in order to predict time for complete soaking and gelatinization. They revealed that soaking rice of 0.1 (d.b.) moisture was completely at 70°C for 130 min, whereas at moisture 0.25 (d.b.) it took 40 min for complete soaking.

singh *et al.* (1980), practiced soaking operation for rough and brown rice at temperature range of 50 to 120°C (10°C intervals), then drying rice

in a natural air drier at regular intervals to a final moisture content of 11 % (d.b.). They found that the gradual increase in soaking temperature was accompanied by gradual decrease in the time required from 480 min at 50°C to 12 min at 120°C, indicating the potential energy savings by dehushing rice before parboiling.

Takano (1980), indicated that parboiling process consists of three steps, i.e., hydration, steaming and drying. The first procedure is soaking the paddy in water at different temperature beginning with room temperature to 70°C for three days to 3 hrs. He added that the temperature depends on the variety. Indica varieties temperature is about 70°C, while Japonica ones it is about 65°C. After hydration, steaming can be done by heating grains to nearly 100°C. Drying the fresh parboiled paddy must practiced immediately after steaming in order to reduce the moisture content to 14 % or less. Drying process usually divided into two stages. In the first stage moisture is reduced to around 18 - 20 %, and 12 - 13 % in the second stage. Between the two stages, the paddy must be kept to several hours for tempering (adjusting moisture content in the kernel).

Pillaiyar and Mohandoss (1981), used soaking rice in water at low and high temperatures, i.e. at 70, 80, 90, 100, 110, and 120°C for 5 and 10 min. duration.

Damir (1983), practiced rice parboiling by steeping clean paddy rice of philippinian long grain variety in water at 65°C for 3.5 hrs, then steamed immediately after water drained (5 min, at 10 PSI until the husk splited out the grain). The grains were air dried after steaming at room

temperature in the absence of direct sunlight to avoid any stress on the kernels until moisture content reached 13.0 % .

Buttow *et al.* (1985), steeped rough rice at steeping temperature of 50, 60 and 70°C for 1, 2 and 3 hrs, then steamed grains at 116°C for 10 - 15 and 20 min. All samples were dried after steaming to 14 % moisture content.

Itoh *et al.* (1985), indicated that increasing steeping temperature increased the rate of water absorption by rice grains. To obtain proper grain moisture steeping must be practiced at 60°C for two hours.

Sesay and Verma (1985), compared three different traditional methods of steaming rice with modern method. For the 1st and 2nd method steaming was carried out for 20 min, under atmospheric pressure. It took 10 min, for the water to start boiling. The 3rd method was conducted by steaming rice samples at pressure of 69 k Pa for 8 min, and that took about 16 min for the pressure to build up to 69 k Pa. After steaming, the samples were subjected to two drying treatments : (D₁) infrared drying, i.e. drying for 3.5 hours under infrared lamps and (D₂) as a combination of infrared and shade drying, i.e. drying for 1.5 hrs with infrared and then under the shade to 12 % moisture content in the grains. However, in the modern method they soaked rice grains for 5 hrs, at 50°C under atmospheric pressure, and steaming was performed for 8 min at 69 k Pa pressure. Upon completion of steaming the samples were subjected to four drying treatments. The first two drying treatments (D₁ and D₂) were as described for the traditional methods. D₃ was one - pass mechanical drying at 90°C for 35 min, and D₄ was two - pass mechanical drying, in which the first pass was at 90°C for 20 min to dry the rice to about 16 %