

“Processing of parboiling paddy and their various effects on rice” A Review

Dimple Chauhan
Amity Institute of Biotechnology
Amity University Rajasthan
dimplechauhan0003@gmail.com

Abstract

Staple food of Bangladesh and Srilanka is parboiled rice. The paddy was absorbed H₂O at 25 and 80 °C for 15, 30, 45, 60 and 120 min. The splashed paddy was brewed, dehydrated, put away and processed. With expanding dousing time a huge increment in water retention and processing and head rice yield (henceforth decrease in broken rice) was watched. An enormous decrease in fissured grain was seen after drenching. It is recommended that parboiling occupies the void places and concretes the splits inside the endosperm, making the grain harder and limiting inner fissuring and in this way breakage during processing. Noticeable variations in the sensory and nutritional qualities of parboiled rice are due to gelatinization, re-crystallization and thermal categorization of starch, variations in protein structures, break of fat globules and diffusion of colour and nutrients

emerging from the hydrothermal treatment.

Key words: Parboiled rice, re-crystallization, hydrothermal, gelatinization, paddy, drenching

Introduction

Rice is the food for almost one-portion of the total people. Rice is created in a wide scope of areas. It is created at temperature scope of 17-33⁰ C and elevation scope of ocean level on seaside fields to a stature of 2,600 meters on the inclines of Nepal’s Himalaya. Above 100 nations of the world produce rice and over 25 nations produce more than one million tons. Practically 90% of world rice is created and devoured by Asian nation. Outside Asia , the second biggest rice creating district is in the Americas (5.5%), trailed by Africa (3.4%) and Europe (0.67%). White rice which is processed from the paddy though parboiled rice alludes to the rice which is incompletely cooked before the

processing in the husk. Rice processed without parboiling (alluded to from this point forward as rice) is white in shading subsequently is called white rice, while rice processed in the wake of parboiling (alluded to henceforth as parboiled rice) is yellowish. About 90% of world's parboiled rice is delivered and devoured in South East Asia, making it the biggest maker and customer. Sri Lanka and Bangladesh parboil practically all the rice they produce and numerous conditions of India additionally deliver and devour parboiled rice. A little extent of the rice created in Pakistan and Nepal is likewise parboiled. In general, it is assessed that 60-65% of rice in South East Asian is parboiled (Bhattacharya, 2011). The utilization of parboiled rice inside this district likewise shifts with ethnic foundation and financial status. A lot of paddies is likewise parboiled in the USA, Brazil, Italy, South Africa, Spain, Thailand, Switzerland and France. The predominance of parboiling additionally relies upon the assortment (cultivar) of the rice and the agronomical conditions that the rice was become under. The assortments parboiled in Bangladesh, Sri Lanka, India and Pakistan is high-amylose rice. Thailand parboils both middle of the road and high-amylose rice, particularly for send out. In the USA, most of the rice parboiled is long-grain and of the middle of the road amylose

content while Italy parboils transitional to low-amylose content coarse japonica rice (Juliano, 1993). High worth rice assortments, for example, long-grain rice is likewise parboiled to boost the processing yield. The agronomical conditions, particularly the climate during the reaping period, likewise decides the requirement for parboiling before processing. For instance, practically all the rice collected during the stormy season (early gathered) is parboiled to lessen the breakage during processing. Parboiled rice can be put away without refrigeration for longer than a year. It tends to be devoured during the time moving along without any more handling aside from bubbling in water and hence, it is viewed as a handily arranged nourishment. Purchasers are progressively picking parboiled rice over different structures since it has a higher B-nutrients and a higher extent of safe starch contrasted with non-parboiled rice. Parboiling likewise offers ventures the open door for item expansion. Parboiling is the halfway bubbling of paddy before processing without modifying the size and state of the grain. In the wake of parboiling, there is a critical change in the material properties of rice grain because of the gelatinisation, re-crystallization and warm breakdown of starch, denaturation and disulphide connecting of the proteins, crack of fat globules and the outward dispersion of

fats (Bhattacharya, 2004), arrangement and dissemination of shading substances and B-nutrients, change in grain mechanical properties and thusly in the cooking and eating quality. Be that as it may, there are some negative effects on quality characteristics emerging from the material changes in parboiled rice. Parboiled rice is at times less favoured by shoppers because of its yellowish shading (which relies on the seriousness of warmth treatment), periodic off flavour (because of substandard parboiling procedures) and longer cooking time. Modernly, processors might be worried that parboiled rice is increasingly hard to process because of its reduced attachment between the pericarp and endosperm that the grain agglomerates and stops up the sifters, and the necessity for more noteworthy processing pressure.

The adjustments in the previously mentioned material properties are needy upon the diverse parboiling techniques utilized, which go from conventional 'splash channel cook-dry' strategies to 'dry warmth' parboiling. To prescribe enhancements in parboiled rice handling, a superior comprehension of material properties changes happening during preparing is fundamental. Among others, dispersion is a key factor in controlling the adjustment in material properties of

rice parts during the parboiling procedure. Thus, this examination has concentrated on the material changes that are brought out by dissemination forms in rice grains.

An overview of parboiling

Parboiling is vitality and works escalated pre-processing process planned for improving the nature of rice. Parboiled rice got by treating paddy rice with water and warmth before it is dried and processed. In South Asia, 90% of the world's parboiled rice is created and expended. Utilization of parboiled rice appears to have been expanding as of late. Processing of paddy with no pre-treatment is profoundly defenceless to breakage and loss of minerals and nutrients. To diminish breakage and loss of minerals and nutrients. Pre-treatment known as parboiling was created. The reason for the procedure is to create physical and concoction alteration in the grain with monetary, wholesome and viable points of interest. During parboiling, irreversible expanding and combination of starch granules happens and changes starch from crystalline to indistinct structure.

Methods of parboiling rice

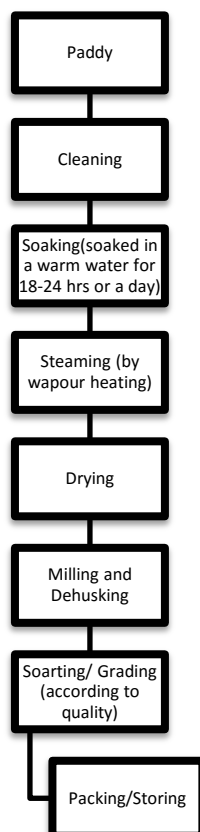
These were the conventional technique, improved procedure and present day the technique of which the initial two

are polished in Ghana. The customary philosophy utilizes basic devices like earthen or metal cooking pots and a close-by stream or dam fills in as a wellspring of water. The paddy isn't cleaned before dousing and the power of warmth supply was high Also the volume of water utilized at splashing and steaming stage is the equivalent. The cutting edge parboiling technique utilizes refined apparatuses like tanks, electric warmers, steam pipes and so on and best in class gear to do the drenching, steaming and drying forms.

The improve strategy is a mix in bits of the customary and present-day strategies. In the improved approach, pre-dousing exercises, for example, washing, destoning, the partition of juvenile seed and so on are done. Dousing is done in warm water not bubbling water. Likewise, little water is utilized at the steaming stage when contrasted with the high volume of water utilized in a customary strategy that will normally be cooked the paddy toward the finish of the procedure.

Processing of parboiling paddy rice

Flow chart:



1. Sieving: This is done if there are broken grains in the paddy. A wire netting is utilized to sifter to isolate the messed up pet hotels with the goal that they won't get cooked and stick the substance together during parboiling. Thick gooey fluid emerging from cooked broken-bits typically stacks the paddy together and hampers compelling quick drying. This could prompt parasitic development and waste of the rice if care isn't taken.
2. Washing, Floation and Sedimentation: The paddy is submerged in water and mixed enthusiastically for the dirt and other earth to break down out. The lighter flotsam and jetsam glide whiles the heavier materials settle at the base. The drifting trash (dead bug parts, weeds, unfilled seeds and so forth) are skimmed off while the paddy rice is scooped out leaving heavier materials (sand, stones, bits of metals and so on.) at the base and poured away. Washing is done twice or thrice relying upon the degree of soil in rice. Experimentally, the washing evacuates soil, flotsam and jetsam and parasitic poison found in the rice.
3. Heating up: The washed paddy is then submerged in water on a pot and incompletely bubbled to warm temperature of 35 to 40⁰C. This upgrades take-up of water by the paddy, and furthermore deactivates certain compounds exercises. A few microorganisms and their cell items could be executed or inactivated at this temperature
4. Soaking: The paddy rice is left to remain in the warm water overnight (10-24 hours) for the paddy to soaked up water and become dampness immersed. The logical standards here are catalysts enactment. A favourable domain is made after content is chilled off for catalysts and colours change. Poisons are weakened and microbial pathogens might be inactivated or evacuated at such high dampness level. The immersed grains extend and fill the body's lemma making it loses all the while.
5. Steaming: The drenched paddy is then steamed in a pot with little water coating the pot. The steam is made to arrive at all segments of the pot by covering with jute sacks and polythene sheets. The covering keeps the steam from getting away effectively subsequently making

a halfway weight over the substance that guides in internal development of particles in each coagulated bit. At the point when paddy starts to air out their husks and there is steam fume emerging all over the pot, it means that steaming is sufficient. The warmth additionally dissipates additional dampness in the grain leaving packed supplements in the bit. The high temperature up to 80⁰C can inactivate or murder a few microorganisms and debase poisons and different noxious substances present in the rice. Physico-concoction response forms for example gelatinization, starch retrograding, colour changes, catalysts deactivations and so on are completely encouraged by the pressurized steaming procedure. This realizes improved flavour, colour change and cooking qualities of the rice.

6. Drying: The steamed paddy is spread out rapidly at a breezy the spot to dry. Inordinate daylight is evaded in any case nonuniform drying of the bit which brings about breakage during processing. Other logical favourable circumstances of the drying forms could be the speciality of drying vanish the

dampness and this packs solutes in the bit drying will likewise stop microbial pathogens from creating on steamed paddy. It packs the coagulated amylase starch together in a minimal mass and delocalizes it from the husk making dehusking (processing) simpler.

7. Processing: The dried paddy is processed devoting a processing machine or on the other hand, at the nearby level is beat appropriating a mortar and pestle to leave the pet motels from the husk. This procedure likewise has the capacity to evacuate pathogens and other earth's that adhere to the frames.
8. Winnowing: Winnowing is done either precisely or physically. Where the processing is done physically utilizing mortar and pestle to pound the paddy rice, the rice is winnowed to separate the husks and outside materials away. Winnowing help to expels earth, dead creepy crawlies, and different polluting influences still present in the rice.
9. Arranging/Grading: Commercial parboiling bunches go further to do handpicking of stained rice and remote materials before arranging into grades (grade 1, 2 and 3) as not many, few what's more, many broken grains

individually). Logical standards (purposes for) parboiling.

Principle of parboiling

Aside from the above reasons, processors couldn't give other logical advantages of parboiling. Indeed, even wholesome improvement, a typical thought the extent that nourishment handling is concern was not referenced because they can't get the collaboration among parboiling and nourishment not to mention the development of water solvent nutrients in rice. This could be followed to the low degree of formal instruction of processors subsequently their failure to make sense of the logical standards and points of interest behind parboiling like inactivation or destroying of organisms, and the weakening of potentially toxic substances. Since it takes scholarly information at a specific level to understand nourishing attributes of nourishment, particularly nutrients, the low degree of formal instruction among the processors, would without a doubt have an impact on healthful issues on their item. Even though not referenced, healthful improvement, particularly nutrient B1 (thiamine) improvement may be one of the significant favourable circumstances of parboiling process. Their outcomes demonstrated that parboiling decreased the breakages, fat, protein and amylose

substance of the rice while the water take-up and thiamine substance were expanded. Moreover, the pre-mediations gave to the rice before the parboiling process help evacuate factors that could estrange the healthful characteristics of the rice. Initially, washing paddy rice in water expels earth, microorganisms and their poisons in the rice. The extended periods of absorbing warm water don't just encourage water assimilation yet additionally further diminishes the substances like aflatoxins that are in the rice during capacity (old stock). This is because the assimilation of water to an immersion point would weaken and diminishes the centralization of dangerous substances in the rice. The drenching may likewise cause certain compounds or colours change and their development inwards to the endosperm. The steaming to a temperature of 80oC supplies heats enough to slaughter pathogens despite everything found in the rice. The movement of pressurized steaming empowered nutrients eminently thiamine to move internal onto the endosperm. It further deactivates catalysts and makes accessible substances like nutrients that in any case could have been blocked off. The change and convergence of catalysts and colours could be the motivation behind why parboiled items, for example, millet, groundnuts, rice and so on tastes better than non-

parboiled ones. In rice parboiling, the significant wholesome and physiological change is the dynamic development of solvent particles. Different favourable circumstances are simple processing of parboiled paddy rice because the amylase starches retrograde and stack together in a minimal way that pulls from the husk at the point when dried. This makes the piece turns out to be to some degree delocalized and now moves uninhibitedly inside the husk. This makes it simpler for husk to be expelled when processed or beat on mortar and pestle. Since the purpose of connection between the husk and the endosperm is additionally released, the husks can undoubtedly get expelled without severing the germ. Non-parboil rice has it husk personally connected to the incipient organism where all the supplements are concentrated. Compelling expulsions of the husk will generally be splitting endlessly the germ with the husk, along these lines losing all the imperative supplements, including thiamine. What's more, such rice will surely not taste equivalent to rice that holds its germ or incipient organism in the wake of parboiling. Along these lines, the way toward parboiling incidentally fixes supplement lacking ailments or can supply certain supplements that in any case could have lost to customers. Various NGOs and some legislature

organizations have started preparing ladies to improve their parboiling exercises. Their endeavours the total of what along has been on how to improve head rice yield (HRY) and dispose of stones in the rice to get great market yet not the healthful viewpoint.

Advantages, disadvantages of parboiling

- The processing yield increment and the quality is expanded as there are fewer broken grains.
- The grain structure gets conservative and vitreous, even if a few bits were totally or somewhat powdery.
- The processed rice gets translucent and sparkling.
- The timeframe of realistic usability of parboiled paddy and processed parboiled rice is longer than in the line state, as germination is no longer conceivable and the bit become hard enough to oppose the assault by creepy crawlies and to adsorption of barometrical dampness.
- The grain stays firmer during cooking and more uncertain to get clingy.
- It lessens the breakage rate during the hulling procedure.
- It makes for improved yield. It assists with lessening

misfortunes of nutritive components during the the procedure of hulling and cooking the rice.

- Through the parboiling procedure, the rice experiences substance, physical and tangible changes as follows: A more prominent measure of water is retained during cooking making the rice swell. After cooking the rice retains less fat from included fixings, the rice keeps longer and doesn't turn into malodorous without any problem.
- Parboiled rice holds more proteins, nutrients and minerals. Shelling of parboiled paddy is simpler. Parboiled rice is progressively absorbable and fewer solids are left behind in the cooking water. Bran of parboiled rice has more oil.

Disadvantages of parboiling;

- The warmth treatment during parboiling wrecks a few common cancer prevention agents, henceforth rancidity created in parboiled rice during capacity is more than that in push rice.
- Parboiled rice sets aside more effort to cook than pushing rice and may have attributes off-

flavour which may not be loved by push rice eaters. Parboiling process needs additional capital venture. Parboiling adds to the expense of drying. As paddy is drenched for a more drawn out time during parboiling, it might be assaulted by spores which may cause wellbeing peril.

- More force is required for cleaning of parboiled rice, the procedure become troublesome and bring down the limit of polisher. Despite the above detriments 1 to 2% additional rice is realistic than push rice processing. In India, if half of the paddy creation is changed over into parboiled rice, it is conceivable to sore about more than 1000millions by uprightness of additional rice and its result esteem.

Impact of parboiling

1. Chemical changes

The water-dissolvable substances (nutrients and minerals) are broken up and permitted to saturate the grains. The lipid materials in the endosperm are broken up. The gelatinized starch seems like a minimal and homogeneous mass. The lipid matter is isolated and goes further into the the smaller mass of gelatinized starch. Fat-dissolvable substances in the germ and the external

piece of the endosperm is broken up and scattered in the grain.

2. Physical changes

Parboiled rice, even without processing, can be better put away also, for a more drawn out period as germination can't happen what's more, the smaller surface of the endosperm permits it to better oppose creepy crawly assaults and not to assimilate dampness from the general condition. Parboiled rice can be rationed longer and is less subject to rancidity. The way toward drying makes it conceivable to lessen the water substance of the grain to an ideal level for processing.

3. Grain measurements :

For each rice assortment and preparing technique, 10 entirety grains were arbitrarily chosen from the processed rice, and the length, width and thickness decided to utilize a micrometre screw check. This estimation whatnot others identifying with physical quality were done in triplicate. All inert or dynamic natural procedures (germination, expansion of contagious spores, and advancement of creepy crawlies at different stages) are ended.

4. Level of contaminations:

A 20 g test of processed rice was gauged. The head rice furthermore, broken grains were

evacuated. The remote issue, for example, dead creepy crawlies, bits of wood, residue, stones and unshelled paddy was then weighed. % Impurities = $\frac{\text{weight of debasements}}{20} \times 100$

5. Sensory evaluation:

The most noteworthy ones are as per the following: Cooked parboiled rice has better absorbability proportion by reason of its surface and firm consistency. After cooking, the grains are firmer and will, in general, be less clingy.

Impact of parboiling on processing quality

In push rice processing a few components are answerable for breakage of the part splitting of the piece is one of the fundamental factors for breakage. Splits created because of postponed reaping, sifting or fast drying. In developing and white apparatus impact processing out turn and quality. Rice breakage is identified with processing conditions, especially by the relative mugginess, temperature and degree of processing. During shelling or husking activity, breakage happens. Parboiling of paddy brings about decrease of breakage imported to a bit on account of gelatinization of starch the splits inadequate grains

filling and whiteness are recuperated. The most points of interest part of parboiling are the expansion in the head the yield of rice during cleaning, the clean rate and breakage with time however parboiled rice takes longer occasions than push the rice to achieve the same level of cleaning. Parboiled rice expects three to fourfold the amount of rough burden as column rice for the same degree of cleaning. According to preferring for the shade of rice the need of cleaning for parboiled rice less when contrasted with push rice for instance if the shopper needs 80% wheat expulsion to accomplish this parboiled rice needs cleaning of 3% whereas push rice must be cleaned to 4% for the same amount of grain evacuation.

Conclusion

The level of gelatinization of starch, a physical, substance and natural parameter of incredible significance in processed rice quality, was resolved, what's more, found to increment on expanding the term of hot drenching. The DSC endothermic warmth stream (DH) of rice starch was seen as needy on drenching span. At the point when the warming rate also, polymer fixations were diminished, gelatinization enthalpy esteems were seen as expanded. The impact of gelatinization on parboiling made the

grain more grounded, which improved processing characteristics. One significant factor for shopper inclination is physical appearance, specifically, translucency, and this was extraordinarily improved by utilizing longer hot splashing treatment delivering a gelatinization of above 57%. The degree of murkiness, different rules for customer inclination, was additionally improved by broadening the hot drenching time. At last, it might be presumed that at least around 45-min splashing at 80°C followed by steaming for around 10 min under 1 air overabundance pressure is important to improve all the required characteristics of rice for better shopper inclination. These figures are the proposal that can be made to the rice mill operators to improve the processing nature of parboiled rice, just as expanding the pace of supply by decreasing the splashing time from 24–48 h to 45–120 min.

References

1. Sunil BW, Juniano OB. Laboratory parboiling procedures and properties of parboiled rice from varieties differing in starch properties. *Cereal chemistry* 1988; 65(5):417-423.
2. Oyedele OA, Adeoti O. Investigation into the optimum moisture content and parboiling time for milling igbemo rice.

JRR, an open access journal. 2013; 1(1):1-3.

3. Cherati FE, Soheila K, Shekofteh M, Razie D. Analysis and study of parboiling method and the following impact on waste reduction and operation increase of rice in paddy conversion phase. *Research journal of applied sciences, engineering and technology*. 2012; 4(16):2649- 2652.

4. Ayamdoo JA, Demuyakor B, Dogbe W, Owusu R. parboiling of paddy rice, the science and perceptions of it as practiced in Northern Ghana. *International journal of scientific and technology research*. 2013; 2(4):12-18.

5. Kaddus MMA, Anwarul H, Douglass MP, Brian C. Parboiling of rice. Part I: Effect of hot soaking time on quality of milled rice. *International Journal of Food Science and Technology*. 2002; 37:527-537.

6. Shabir AM, Bosco SJD. Effect of soaking temperature on physical and functional properties of parboiled rice cultivars grown in temperate region of India. *Food and Nutrition Sciences*. 2013; 4:282-288.

7. Joseph AA, Amikizunu J, Razak AA. Effects of varied parboiling conditions on proximate and mineral composition of Jasmine-85 and Nerica-14 rice varieties in Ghana. *International journal of food research*. 2015; 2:1- 11.

8. Houssou AFP, Gankoue YB, Kabore A, Futakuchi K, Traore K, Moreira J et al. Comparison of parboiled and white rice obtained from ten varieties cultivated in Benin. *International Food Research Journal*. 2016; 23(6):2479-2486.

9. Fofana M, Wanvoeke J, Manful J, Futakuchi K, Van Mele P, Zossou E et al. Effect of improved parboiling methods on the physical and cooked grain characteristics of rice varieties in Benin. *International Food Research Journal*. 2011; 18:715-721

10. Supawan T, Oraporn B, Yutthana T. Study of drying kinetics and qualities of two parboiled rice varieties, Hot air convection and infrared irradiation. *Songklanakarin J Sci. Technol*. 2012; 34(5):557-568,

11. Sunil BW, Juniano OB. Laboratory parboiling procedures and properties of parboiled rice from varieties differing in starch properties. *Cereal chemistry*. 1988; 65(5):417-423.

12. Oyedele OA, Adeoti O. Investigation into the optimum moisture content and parboiling time for milling igbemo rice. *JRR, an open access journal*. 2013; 1(1):1-3.

13. Cherati FE, Soheila K, Shekofteh M, Razie D. Analysis and study of parboiling method and the following impact on waste reduction and

operation increase of rice in paddy conversion phase. Research journal of applied sciences, engineering and technology. 2012; 4(16):2649- 2652.

14. Ayamdoo JA, Demuyakor B, Dogbe W, Owusu R. parboiling of paddy rice, the science and perceptions of it as practiced in Northern Ghana. International journal of scientific and technology research. 2013; 2(4):12-18.

15. Kaddus MMA, Anwarul H, Douglass MP, Brian C. Parboiling of rice. Part I: Effect of hot soaking time on quality of milled rice. International Journal of Food Science and Technology.2002; 37:527-537.

16. Shabir AM, Bosco SJD. Effect of soaking temperature on physical and functional properties of parboiled rice cultivars grown in temperate region of india. Food and Nutrition Sciences.2013; 4:282-288.

17. Joseph AA, Amikizunu J, Razak AA. Effects of varied parboiling conditions on proximate and mineral composition of Jasmine-85 and Nerica-14 rice varieties in Ghana.International journal of food research.2015; 2(1- 11).

18. Houssou AFP, Gankoue YB, Kabore A, Futakuchi K, Traore K, Moreira J et al. Comparison of parboiled and white rice obtained from ten varieties cultivated in Benin.

International Food Research Journal. 2016; 23(6):2479- 2486.

19. Fofana M, Wanvoeke J, Manful J, Futakuchi K, Van Mele P, Zossou E et al. Effect of improved parboiling methods on the physical and cooked grain characteristics ~ 1734 ~ Journal of Pharmacognosy and Phytochemistry of rice varieties in Benin. International Food Research Journal. 2011; 18:715-721

20. Supawan T, Oraporn B, Yutthana T. Study of drying kinetics and qualities of two parboiled rice varieties, Hot air convection and infrared irradiation. Songklanakarin J Sci. Technol 2012; 34(5):557-568,

21. Ibukun EO, Effect of prolonged parboiling duration on proximate composition of rice. Scientific Research and Essay 2008; 3:323-325.

22. Bhattacharya KR. Parboiling of Rice. In: Juliano, B.O. (Ed.), Rice Chemistry and Technology. American Association of Cereal Chemists, Inc. Minnesota, 1985, 289-348.

23. Elbert GM, Tolaba P, Suarez C. Effects of drying conditions on head rice yield and browning index of parboiled rice. J Food Eng. 2000; 47:37-41.

24. Luh BS, Mickus RR. Parboiled Rice. In Luh, B.S. (Ed.), Rice: Products

and Utilization. Westport, AVI Publishing Company Inc, Connecticut, 1980, 501-542.

25. Larsen HN. Glycaemic index of parboiled rice depends on the severity of processing: Study in type 2 diabetic subjects. *Eur. J Clin.Nut.* 2000; 54(5):380-385.

26. Bello M, Baeza R, Tolaba MP. Quality characteristics of milled and cooked rice affected by hydrothermal treatment.*J Food Eng.* 2004; 72:124-133.

27. Pillaiyar P. A gel test to parboiling rice using dimethyl sulfoxide.*J of Food Science Technology.* 1985; 22(1):1-3.

28. Eliasson AC. Viscoelastic behaviour during the gelatinization of starch. *Journal of Texture Studies.*1986; 17:253-265.

29. Gariboldi. In FAO corporate document repository: Rice in human nutrition. Rice post-harvest processing, parboiling and home preparations, 1984.

30. Helbig E, Dias A, Tavares R, Schirmer M, Elias M. The effect of

parboiled rice on glycemia in Wistar rats.*Archivos Latinoamericanos De Nutricion.* 2008; 58(2):149-155.

31. Marshall WE, Wadsworth JI, Verma LR, Velupillai L. Determining the degree of gelatinisation in parboiled rice: comparison of a subjective and objective method. *Cereal Chemistry.*1993; 70:226-230.

32. Joachim S. Parboiling in Thailand and the World. Kasetsart University, 2011.

33. Otegbayo BO, Osamuel F, Fashakin JB. Effect of parboiling on physico-chemical qualities of two local rice varieties in Nigeria. *J Food Technol.* 2001; 6(4):130-132.

34. Pillaiyar P. Household parboiling of parboiled rice. *Kishan World.* 1981; 8:20-21.

35. Helbig E, Dias A, Tavares R, Schirmer M, Elias M. The effect of parboiled rice on glycemia in Wistar rats.*Archivos Latinoamericanos De Nutricion.* 2008; 58(2):149-155 K.