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Parboiling Influence on Physicochemical Characteristics of Kernel Basmati Rice

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Abstract:

The study was conducted to observe the parboiling influence on physic-chemical characteristics of kernel basmati rice examined. The experiment has different temperature regimes T1 30 ^{0}C, T2 40 ^{0}C, T3 50 ^{0}C and T4 60 ^{0}C.The result of present study shows that highest kernel length remained 7.76 mm in T3. Highest hardness of grain kernel (Newton) was observed in T0 (192.33 Newton).The highest moisture content was observed (8.20 %) in control. The highest average

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pH was observed (7.29) in T4. Maximum TSS (mg/1) was (0.57) found in T1. The highest ash (%) was examined (1.35 %) T4. Maximum fat content was (2.25%) found in T0 (control), Maximum crude fiber (1.56%) was observed in T4, while (1.36%). Highest protein content (8.88%) was found in control T0 (control), Maximum total carbohydrate (82.30) was found in T4. The sensory analyses indicate that in T0, T1, T2, T3, and T4 the colour of parboiled kernels obtained score of 8.66, 7.43, 6.16, and 3.73 (out of 10); taste 7.73, 5.37, 6.40, 8.33, and 3.96:Appearance 8.66, 6.16, 4.93, 7.433 and 3.73: tenderness 8.66, 4.03, 4.80, 7.16, and 5.83: over all acceptability 8.90, 5.06, 6.33, 7.53 and 4.03 respectively. It was noted that moisture content, hardness, width protein and fat content was high in (control); while ash crude fiber, total carbohydrate and pH are high in T4. In case of Sensory characteristics, the T3 obtained higher marks as compared to other treatments; but the maximum marks were obtained by non-parboiled rice (control).

Key words: Sensory evaluation, paddy kernels, parboiling, Physicochemical, Soaking

INTRODUCTION

Parboiling is a technique developed to enhance rice quality. It includes soaking, steaming and drying of the rough rice. The most important reasons for parboiling of rice is to get higher milling yields, more dietary value and tolerance to spoilage by various insects and mold (Elbert et al., 2000). The main object of parboiling process is hardening of kernel in order to increase head rice yield in milling. Besides milling yield of parboiled brown rice it also increase nutritional value of rice (Larsen, 2000).

Various rice processing industries runs globally and also using parboiling technique at developing countries. Globally peoples of all age's consumers parboiled rice. Near about one fifth rice are passed from parboiling process. Majority of Indian and Bangladesh peoples eats parboiled rice there ratio is about 60 to 90%. Parboiling of paddy is a hydrothermal process, which changes the crystalline structure of starch into amorphous shapes due to irreversible swelling of starch. Parboiling process increases the dietary values of rice and also prevents their losses during rice milling. That gives batter yield for consumers to achieve their desirable requirements (Otegbayo et al, 2001).Before 3000 years ago, This procedure was start in Indian subcontinent, in a very simple form for the first time and has improved gradually until now that, it is used in most of southeast Asia countries like; Sri Lanka, Thailand, China, Bangladesh, Philippines, Japan and Nepal.

The old method of parboiling process contain soaking of paddy or rough rice overnight in to water at room temperature, followed by boiling or steaming at 100°C to gelatinize the starch. A range of factors (genetic make-up and environmental factors) combines to affect the quality of rice from the paddy storage through to the superiority of the final product. On the other hand, a minor quantity emphasis has all along been placed on particularly the effect of prolonged parboiling period on the rice quality. The kernel expands until the hull's lemma and palea begin to split out. Before storage and milling parboiled rice are cooled and dried by sun (Miah *et. al.*, 2002).

Nutrients are derived during parboiling, almost, vitamins, from the fibre to endosperm (Kyritsi et al., 2011), that's why parboiled white rice is 80% nutritionally similar to brown rice. Due to this, nowadays more than 80% countries of the world are using parboiled rice. Parboiled rice takes little time to cook and is firmer and less sticky. The main purpose of parboiling rice includes advanced milling yields, higher dietary substance and resistance to contamination by insects and mold (Elbert et al., 2000).

Parboiling is also necessary in reducing the losses of starch, vitamins, and minerals in cooking, damage of infestation molds and insects, and removal of enzyme to increase shelf life of rice fibre. Parboiled rice has a quality texture, flavour, Color, taste, and cooking manners. 25 to 30 % of the world paddy was parboiled in the year of 1972. It is an advance treatment to remove the threshed kernel, or since of its hardening effect and resultant upgrading of quality.

MATERIALS AND METHODS

The experiment was conducted at Laboratory of Institute Food Sciences and Technology, Faculty of Crop Production, Sindh Agriculture University Tandojam. Husked kernel basmati were collect from nuclear institute of agriculture Tandojam. Husked kernel rice were brought to the laboratory. Initially the husked rice were cleaned, weighted about 100 gram, then each divided in to four group of parboiling. In group A (T1), the dehusked kernel were soaked at 30 ^{o}C for 3 hours group B (T2) dehusked kernel were soaked at 40 ^{o}C for 3 hours, the group C (T3) dehusked kernel were 50 ^{o}C and D (T4) dehusked kernel were soaked at 60 ^{o}C .

Treatments

T_0 =Non Parboiled kernel
T_1 =soaking of kernel at 30 ^{o}C for 3 hour
T_2 =soaking of kernel at 40 ^{o}C for 3 hours
T_3 = soaking of kernel at 50 ^{o}C for 3 hour
T_4 = soaking of kernel at 60 ^{o}C for 3 hours

After completion soaking kernel were dehusked by huller, then samples were taken for physico-chemical analysis. The following physico-chemical and sensorial qualities were determined:

Physical analysis:

1. Length of grain (mm)

The length of husked kernel was taken by using measuring scale.

2. Width of grain (mm)

The width of husked kernel was measured by using Digital Vernier Caliper.

3. Hardness of kernel (Newton)

The hardness of husked kernel was recorded by using Hardness meter.

Chemical analysis

Moisture content (%)

The moisture content was determined according to AOAC (2000) oven method. The loss in weight was regarded as a measure of moisture content which was calculated by the following formula:

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh sample- Weight of after drying}}{\text{Weight of fresh sample}} \times 100$$

pH

Determination of pH (hydrogen ion concentration) in the parboiled rice, a method of AOAC (2000) was utilized. A digital pH meter was used. Sample solution was taken in the breaker and directly inserted the electrode keen in the solution. All readings were achieved by this method.

Total soluble solids (%)

TSS was observed via Atago RX 1000 digital refractometer. A drop of ready sample (liquid) was positioned on clean prism of

Refractometer and the cover was closed. Reading was note directly from the scale at ambient temperature

Determination of ash content (%)

For determination of ash content, method of AOAC, (2000) was applied. In this process 10 gram of every sample was weighed in china dish. The china dish was placed in a muffle furnace for about 4-5 hours at 525^{o}C. Cool and weighed. To make sure end of ashing, it was heated once more in the furnace for half an hour further, cooled and weighed. Weight of ash was calculated by the following formula:

$$\text{Ash \%} = \frac{\text{Weight of sample after ashing}}{\text{Weight of total sample}} \times 100$$

Fat

The crude fat content of the rice samples was determined using the soxhlet method. 2.5 gram of samples was extracted by 150 ml of petroleum ether and heated at 80 °C for 6-8 hours. After extraction, the soxhlet flasks were dried over the hot plate and placed in an oven at 105 °C for 1 h. The flasks were cooled for 25 minute and weighed. The fat content was measured as given bellow

$$\text{\% Crude fat} = \frac{\text{Weight of oil in sample}}{\text{Weight of sample}} \times 100$$

Determination of protein (%)

For determination of protein (%), method of AOAC, (2000) was followed. Weight the 0.2-1.0g. Sample was digesting by the help of 0.5g of copper sulphate and 5gram of potassium sulphate and 25 ml of sulphuric acid in digestion Unit. Cool digest sample at ambient temperature after distilled by distillwater 50 ml of hydrochloric acid (0.1M) 3-5 drops methyl red indicator and 150-200ml of NaOH (30%). After this process, titrate by sodium hydroxide (0.1M) till pink colour is come out note the reading on burette and calculate the nitrogen %. First the nitrogen content has been determined then it is change into protein content using the suitable changing factor.

$$\text{Nitrogen (\%)} = \frac{(\text{Blank - Titer}) \times 0.0014 \times 100}{\text{Weight of sample}}$$

$$\text{Protein (\%)} = \text{Nitrogen\%} \times \text{Factor of protein}$$

Crude fiber

Crude fiber content was done via the Official Methods of Analysis of the AOAC (2000) with some modifications.

$$\text{\% Crude fiber} = \frac{\text{weight of crucible before ashing} - \text{weight of crucible after ashing}}{\text{Weight of sample}} \times 100$$

Total Carbohydrate

For determination total carbohydrate, method of AOAC, (2000) was followed. The total carbohydrate are analysed by following formula:

100gram sample - Protein - Fat - moisture – Ash –crude fiber

Sensory analysis

The sensory qualities of dehusked kernels included colour, flavour, taste, tenderness, appearance and our all acceptability. These were assessed by a panel of five judges to rank the samples out of 10 marks. For this purpose, ddifferent fruit samples were evaluated organoleptically through five semi-trained judges as described by Land and Shapherd (1988).

Statistical Analysis

The collect data was subjected to analysis of variance (ANOVA) Difference between the means were calculated by using Fisher's least significant difference (LSD) test at 0.05% level of probability through Student Edition of Statistic, Version 8.1 (Statistic, 2006).

RESULTS

Various physical properties including length of kernel, width of kernel and hardness of kernel, while chemical properties included Moisture (%), pH, Total Soluble Solids (%), Ash (%), crude fibber, fat, protein and Total carbohydrates Sensory analysis, Colour, taste, tenderness ,appearance and overall acceptability. The data on these characteristics are presented in Fig 1 to 15. The results on the above parameters are interpreted as follows

Length of parboiled kernels (mm)

The results in relation to length of kernel basmati rice as parboiled by various temperatures and control (non-parboiled kernels) are given in Fig-1.The analysis of variance showed that the kernels length varied non-significant (P>0.05) when processed by different temperatures.

It is evident from the data (Table-1) that length of kernel was highest (7.76 mm) in (50 ^{0}C), followed by (7.10 mm) (40 ^{0}C) average length of kernels processed by parboiling method, and lowest length of kernel was (6.26 mm) in control.

It can be noticed that the length of kernels increased due to parboiling process. However, LSD test suggested that the differences in length of kernels under different temperature parboiling methods were non-significant (P>0.05). However there were non-significant effects observed in parboiled kernels.

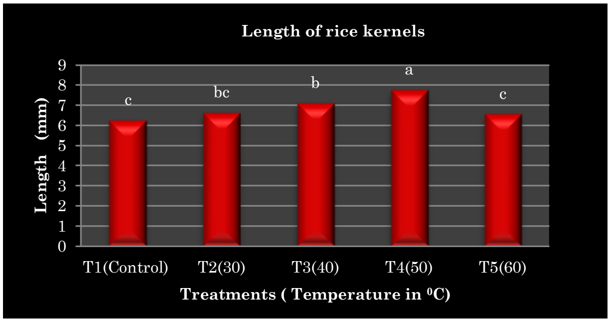


Fig .1. Length of kernels rice (mm) as parboiled by different temperatures

Grain width

The results in relation to width of kernel basmati rice as parboiled by various temperatures and control (non-parboiled kernels) are given in Fig-2 .The analysis of variance showed that the width of kernels varied non-significant (P>0.05) when processed by different tem It is evident from the data (Fig-2) that highest width was recorded in (control) ((1.800 mm) and lowest length of kernel was (1.200 mm) in (T_4).

It can be noticed that the length of kernels increased due to parboiling process. However, LSD test suggested that the differences in kernels length under different temperature parboiling methods was non-significant (P>0.05). However there were non-significant effects observed in parboiled kernels

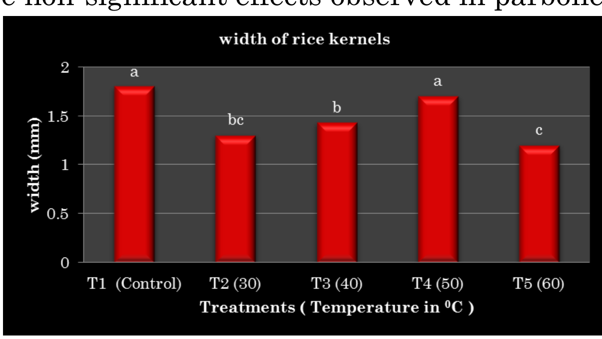


Fig: 2 Width of kernel rice (mm) as parboiled by different temperatures

Grain hardness (Newton)

The data pertaining to grain hardness (Newton) of parboiled rice processed by various temperatures and compared with control (non-parboiled rice) are mentioned in Fig-3. Analysis of variance illustrated that the hardness of parboiled rice's significantly (P<0.05) due to different temperatures of parboiling. It can be seen from the results that the maximum hardness of kernel (192.33 N) was examined in control (non-parboiled rice), and lowest hardness of kernel was (160.33) in (T_2). It was noted that regardless of parboiling, the hardness of kernels was decreased markedly with parboiling process. The LSD test suggested that the differences in hardness of kernels under different temperatures were significantly (P<0.05) difference from another.

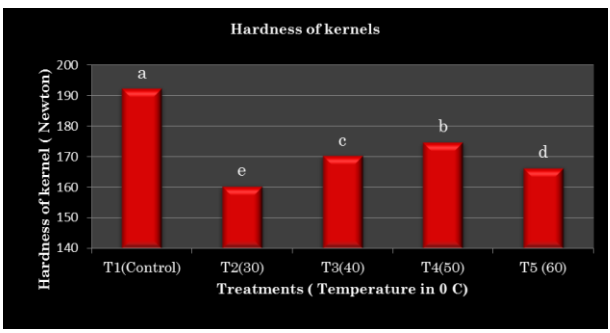


Fig -3 Hardness of kernel (Newton) as parboiled by different temperatures

Grain moisture

The data in relation to moisture content in the kernels as treated by different parboiled rice as compared to control (brown rice) are presented in Fig-4 .The analysis of variance showed that statistically the differences in moisture content of parboiled rice by different temperatures and control were non-significant (P<0.05). The results showed that the highest moisture content (8.20%) in control brown rice, while the lowest moisture content of (4.86 %) was recorded in (T_2).

LSD test suggested that there was linear effect of drying methods on moisture content of kernel rice.

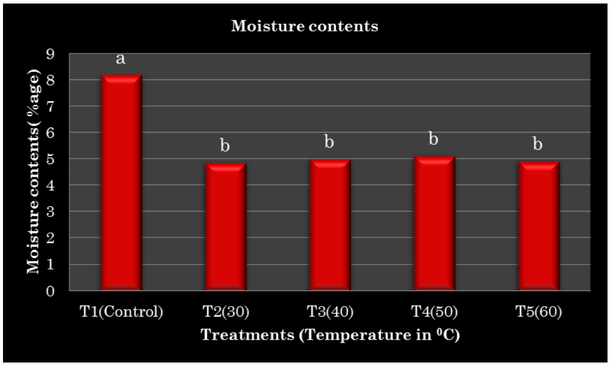


Fig- 4. Moisture content of kernel rice (%) as parboiled by different temperature

pH

The results regarding pH of the parboiled rice's as treated by different temperature of parboiling and control (non-parboiled rice's) are given in Fig-5 and analysis of variance suggested that statistically the pH of parboiled kernels and non-parboiled rice are not significantly (P>0.05) difference from another.

It is evident from the results (Table-5) that the highest pH of kernel was found (7.21) in (T4) at (60 ^{0}C), While the lowest pH (6.61) was found in control. It was further noted that on average, the pH of parboiled kernel were relatively high.

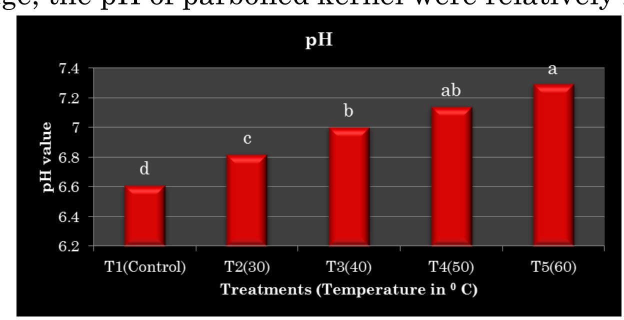


Fig-5 pH of kernel rice as parboiled by different temperatures

TSSmg/1

The results regarding TSS of the parboiled rice's as treated by different temperature of parboiling and control (non-parboiled rice's) are given in Fig-6 and analysis of variance suggested that statistically the TSS of parboiled kernels and non-parboiled rice are not significantly ($P>0.05$) difference from one another.

It is evident from the results (Table-6) that the maximum TSS of parboiled kernel was observed in T_4 (0.57 mg/1).while lowest TSS value was found in control T_0 (0.413 mg/1). It was noted that on average, the TSS of parboiled kernel were relatively high.

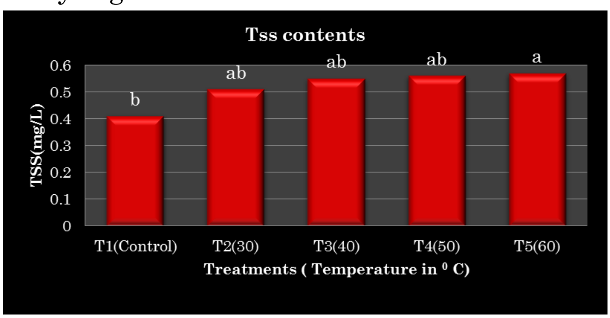


Fig-6 TSS mg/1 content of kernel rice as parboiled by different temperatures

Ash (%)

The data pertaining to Ash of parboiled rice processed by various temperatures and compared with control (non-parboiled rice) are presented in Fig-7.Analysis of variance illustrated that the ash of parboiled rice's significantly ($P<0.05$) due to different temperatures of parboiling. It can be seen from the results that the maximum ash of kernel (1.35) was examined in (T_4), and minimum ash of kernel was found in (0.87) in control. It was noted that regardless of parboiling, the ash of kernels was increased markedly with parboiling process. The LSD test suggested that the differences in ash of kernels under different temperatures were significantly ($P<0.05$) difference from another.

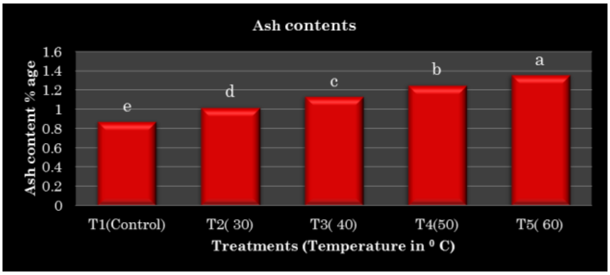


Fig-7 Ash content (%) of kernel rice as parboiled kernel by different temperature

Fat (%)

The data regarding fat percentage of parboiled rice processed by various temperatures and compared with control (non-parboiled rice) are presented in Fig-8 .Analysis of variance illustrated that the fat of parboiled rice's significantly ($P<0.05$) due to different temperatures of parboiling. It can be seen from the results that the maximum fat of kernel (2.25) was examined in control, and minimum fat of kernel was found in (1.65) in T_4.

It was noted that regardless of parboiling, the fat of kernels was decreased markedly with parboiling process. The LSD test suggested that the differences in fat percentage of kernels under different temperatures were significantly ($P<0.05$) difference from another.

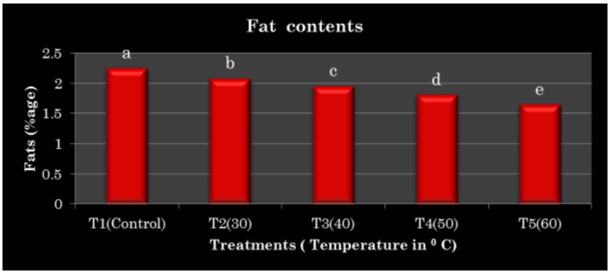


Fig-8 Fat (%) of kernel rice as parboiled kernel by different temperature

Crude fiber

The data regarding crude fiber percentage of parboiled rice processed by various temperatures and compared with control (non-parboiled rice) are presented in Fig-9. Analysis of variance illustrated that the crude fiber of parboiled rice's significantly ($P<0.05$) increase due to different temperatures of parboiling. It can be seen from the results that the maximum crude fiber of kernel (1.56) was examined in (T_4), and minimum fat of kernel was found in (1.30) in control. It was noted that regardless of parboiling, the crude fiber of kernels was increased markedly with parboiling process. The LSD test suggested that the differences in fat percentage of kernels under different temperatures were significantly ($P<0.05$) difference from another.

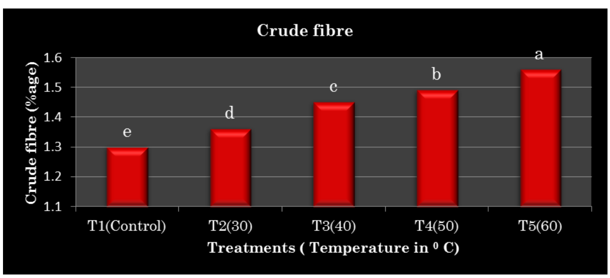


Fig-9 Crude fiber (%) of kernel rice as parboiled kernel by different temperatures

Protein

The data in relation to protein content of parboiled rice processed by various temperatures and compared with control (non-parboiled rice) are presented in Fig10 .Analysis of variance illustrated that the protein content of parboiled rice's significantly ($P<0.05$) denature due to different temperatures of parboiling.

It can be seen from the results that the maximum protein content of kernel (8.88) was observed in control, and minimum protein content of kernel was found in (8.19) T_4.

It was noted that regardless of parboiling, the protein content of kernels was decreased markedly with parboiling process. The LSD test suggested that the differences in protein content of kernels under different temperatures were significantly (P<0.05) difference from another.

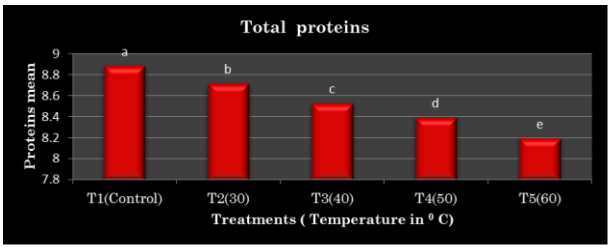


Fig-10: Total carbohydrate of kernel rice as parboiled kernel by different temperatures.

Total carbohydrate

The data in relation to total carbohydrate in the kernels as treated by different parboiled rice as compared to control (non-parboiled rice) are presented in Fig10 .The analysis of variance showed that statistically the differences in total carbohydrate of parboiled rice by different temperatures and control were non-significant (P<0.05). The results indicated that the highest total carbohydrate was found (82.30) in (T_4), while the lowest total carbohydrate (78.49) was recorded in control.

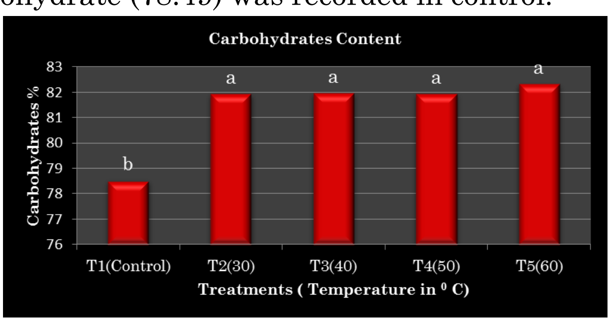


Fig-11 Total carbohydrate (%) of kernel rice as parboiled kernel by different temperatures

SENSORY EVALUATION

The krenel rice's are parboiled at 30 ^{0}C, 40 ^{0}C 50 ^{0}C 60 ^{0}C and non-parboiled rice's to evaluate the different sensory attributes like color, taste, appearance, tenderness and overall acceptability.

Color of parboiled rice kernels

The data for color is presented in Fig.12 .The analysis variance indicated that the difference in the color were statistically significant at (P<0.05) probability level. The result indicated that highest received maximum score (8.84) was achieved by non-parboiled control, However minimum score (3.73) for color in T_4.

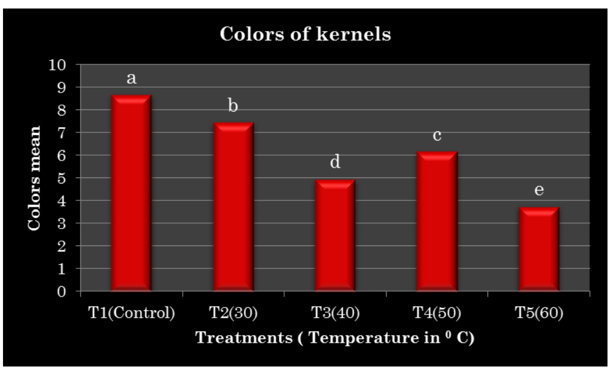


Fig – 12. Color of kernel rice as parboiled kernel by different temperatures

Taste of parboiled rice kernels

The data for taste score is mentioned in Fig.13 .The analysis variance indicated that the difference in the taste were statistically non-significant at (P>0.05) probability level. The result indicated obtained T_3 received maximum score (8.33) among all other treatments, However minimum score (3.96) for taste of kernel rice was noticed in T_4.

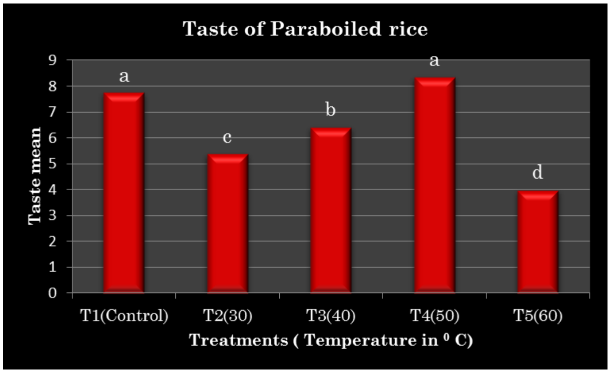
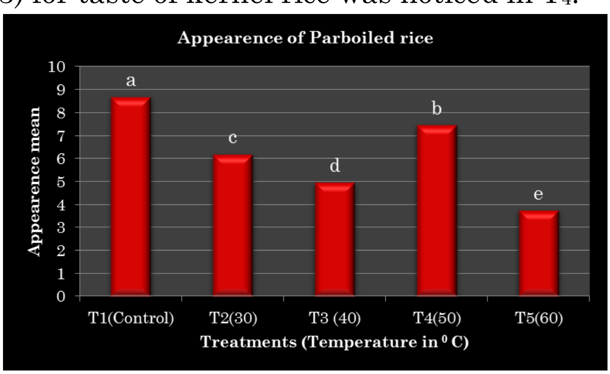


Fig – 13. Taste of parboiled kernel rice as parboiled by different temperatures

Appearance of parboiled kernels

The data for appearance score is show in Fig.14 .The analysis variance indicated that the difference in the appearance were statistically significant at (P<0.05) probability level. The result indicated obtained non parboiled rice (T_0) received maximum score (8.66) among all other treatments, However minimum score (3.73) for taste of kernel rice was noticed in T_4.

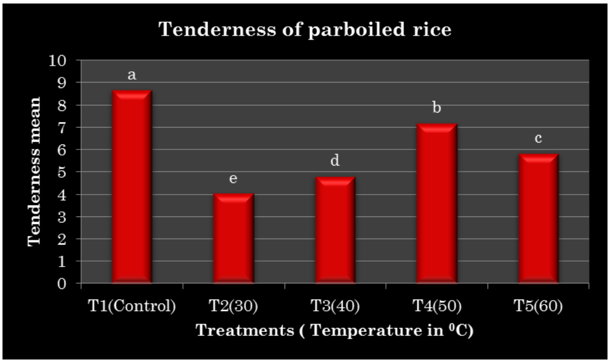


Fig–14. Appearance of parboiled kernel rice as parboiled by different temperatures

Tenderness of parboiled kernel

The data for tenderness score is tabulated in Fig.15 .The analysis variance indicated that the difference in the tenderness were statistically significant at ($P<0.05$) probability level.

The result indicated obtained non parboiled rice (T_0) received maximum score (8.66) among all other treatments, However minimum score (4.03) for taste of kernel rice was noticed in T_1.



Fig–15. Tenderness of parboiled kernel rice as parboiled by different temperature

Over all acceptability

The data for overall acceptability score is showed in Fig.16. The analysis variance indicated that the difference in the tenderness were statistically significant at ($P<0.05$) probability level. The result indicated obtained non parboiled rice (T_0) received maximum score (8.90) among all other treatments, However minimum score (4.03) for taste of kernel rice was noticed in T_1

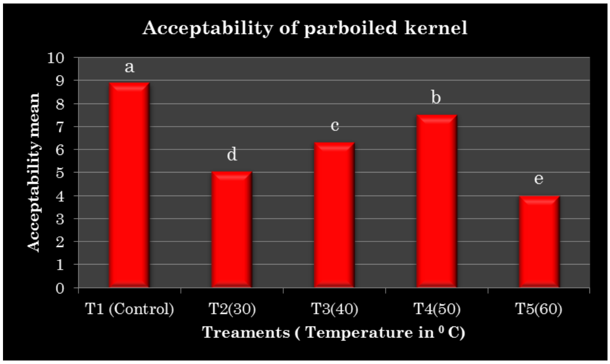


Fig: 16. Over all acceptability of parboiled kernel rice as parboiled by different temperatures

DISCUSSION

For present study, Rice kernel are parboiled at the temperature (30, 40, 50 and 60 ^{0}C) in the laboratory of Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam, during the year 2015.The result obtained from present study showed that highest Length (mm) of kernel was recorded in (mm) was found in 7.76mm in T_3 followed by 6.26 mm in control. The highest width of kernel was observed in control 1.80 mm while the lowest kernel width was found in T_4. The results are agreement with the research conduct by Saif et al (2004) the length and width of parboiled rice were about 7.0-9.0 mm and 1.02-2.06 mm, in that order, which were larger and shorter than non-parboiled rice.

Highest hardness was recorded in control (192.33 Newton) and the lowest (160.33 Newton) was recorded in T_1. Present results are supported by Sareepuang *et al.* (2008) according to their study highest hardness was (190-212 Newton) in brown rice while in parboiled (160-170). Maximum moisture content was found in (8.20) in control. While minimum moisture content (4.86) was found in T_1.the results accordance with the research conduct by Heinemann et al.

(2005) moisture cont. of no parboiled was recorded (8.58-11.63%) for parboiled, (5.36 -3.66%).

Ayamdoo et al (2015) The results obtained for moisture content for raw rice explain a minor reduce in the moisture content of un parboiled rice when compared to the standards obtained for parboiled rice. Present outcome is in conformity with Ogbonnaya Chukwu and Friday James Oseh (2009) who verified that the moisture content of rice reduces under slow raise in temperature of parboiling and consequent exposure to air.

The highest pH was recorded (7.21) in T_4 and the lowest pH was recorded in (6.61) in control. The result of pH findings related to the pH are in line with the findings of Testuya iwasaki and Tatsuotani (2000), they find that pH values of parboiled rice are 7-0 to 7.3 under different parboiling temperature.

The highest TSS (0.56 mg/1) was found in T_1 while the lowest TSS (0.41 mg/1) was found in control. The highest ash of kernel rice was observed in (1.35) in T4 while the lowest ash (0.87) in Control. This result is in accord by A. J. kale *et al* (2015) they find that ash content of non-parboiled rice was (0.80) while the ash content of parboiled rice was (1.30-1.62) on different temperatures.

The maximum fat percentage was recorded (2.25) in control while minimum fat percentage was recorded (1.65) in T_4. The results are accordance with the research conduct by Farhan Saeed et al (2012) they find that fat percentage of different verities of kernel basmati are (2.00-3.15 %) while in parboiled rice (1.90-0.91 %).

Highest crude fiber was found (1.56) in T_4 while the lowest crude fiber was found (1.30) in control. A. J. kale et al (2015) they find that crude fiber of non-parboiled rice was (0.83-1.52%) while the crude fiber of parboiled rice was (1.30-1.62) on different temperatures.

Result shows that maximum protein content was observed (8.88) in control while minimum protein content was observed (8.19) in T_4. The results are agreed by the research conduct by Akhter et al (2014) they find that protein content of different verities of kernel basmati are (7.09-9.1%) while in parboiled rice (8.66-6.91%).

Highest total carbohydrate were observed (82.30) in T_4 while lowest total carbohydrate were observed in (78.49). Ogbonnaya Chukwu and Friday James Oseh (2009) the results are accordance with the research conduct by they find that total carbohydrate of brown rice are (75-80%) while in parboiled rice (80-86%). Same results were obtained by Akhter et al (2014).

Sensory Evaluation

The study on sensorial evaluation of parboiled rice showed that the non-parboiled rice achieved highest score for colour (8.66), taste (7.33), appearance (9.00) tenderness (8.66) and overall acceptability (8.90). Overall sensory score of all judges was higher among 4 different parameters color, flavor, and taste and overall acceptability. Similar results have also been reported by Sareepuang *et al.* (2008) conducted experiment Effect of Soaking Temperature on Physical, Chemical and Cooking Properties of Parboiled Fragrant Rice.

CONCLUSIONS

1. Soaking temperature is one of the most essential steps of rice parboiling. Current results verified that significant differences were found inside physical, chemical and cooking properties of parboiled rice compared to non-parboiled rice.
2. Soaking temperature is responsible for nutrient changes such as protein, lipid and ash contents.

3. According to current information, we particularly suggest that this practice is best for broken fragrant rice for enhancement of top rice yield and cooking value. Further, superior nutritional standards of treated rice are future measured as a usable food.

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