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# Malting characteristics of Ofada rice: chemical and sensory qualities of malt from ofada rice grains

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**Abstract:** A study was conducted to evaluate the malting quality of *Ofada* rice and determine the chemical and sensory qualities of malt from *Ofada* rice and in combination with other local cereals. Malting parameters measured were; germinating energy, germinating capacity, malting loss, malting yield, and cold water extract. The result showed that *Ofada* rice had high malting quality with germination energy of 93.7%, germination capacity of 83.33%, and malting yield of 81.43%. The dry matter content of the malt samples ranged from 10.80 – 12.06% with malt from 100% maize having the lowest value and malt from 50% *Ofada* and 50% sorghum having the highest value. The highest value of protein (1.35%) was recorded by malt from 100% sorghum while malt from 50% *Ofada* rice and 50 % maize had the lowest. Fat, sugar and starch contents of the malt samples ranged from 0.12 – 0.32%, 8.28 – 9.09% and 6.49 – 7.91%, respectively. The pH of the malt samples ranged between 4.90 and 5.06 with malt from 100% *Ofada* rice having the lowest and malt from 100% sorghum having the highest. Present gravity of the malt samples ranged from 12.10 – 12.30 with malt from 100% *Ofada* having the highest value and malt from 50% *Ofada* rice and 50% maize having the highest value. There were significant differences in the chemical and sensory qualities of malt from *Ofada* rice, maize and sorghum grains. The malts were found to be acceptable with slight difference when compared with Vitamalt™ by sensory evaluation. Based on the outcome of the study of the malting qualities of *Ofada* rice,maize and sorghum, *Ofada* rice was observed to have good malting qualities, hence it can be used as an alternative in malting.

**Keywords: Ofada rice, malt, chemical, sensory properties**

## Introduction

Malting is the process applied to cereal grain in which the grains are made to germinate and then quickly dried before shoot development (Jonathan, 1983). Malting involves germination of grains until the food-store (endosperm), which is available to support the development of the germ of the grain, has suffered some degradation from enzymes (Hough *et al*, 1982). During malting, the germination of the grains facilitate the production/release of enzymes which helps to modify the grains (i.e. attack the starch) to an optimal level of brew's extract. Both Alpha-amylase and Beta-amylase are involved, the Alpha-amylase (liquifies) the starch while the Beta-amylase acts to increase the reducing sugar formation through a process known as *saccharification.* In orthodox brewing, the primary raw material is barley because of its outstanding malting qualities. However, barley is not locally produced in Nigeria and the high cost of importing conventional brewing ingredient into Nigeria led to the adaptation of locally available food commodities — substitutes such as rice, maize and sorghum (Berry, 1991).

The economic situation with its consequent shortage of foreign exchange has made it necessary for many developing countries to examine the possibility of replacing imported industrial raw materials with local ones. In Nigeria, the brewing industry is one of the largest in the economic sector. Unfortunately, its chief raw material, barley malt, must be imported because barley does not grow in Nigeria. Three tropical cereals malted or unmalted have been recommended for use in the Nigerian brewing industry: sorghum, maize and rice (Adewoyin, 1985). Among these, sorghum has been much studied as a replacement for barley at the experimental and industrial levels (Okafor and Aniche, 1980; Aisien, 1988). Malted maize has received some attention as a replacement for barley malt (Adewoyin, 1985). However, as far as the present authors are aware, malted *ofada* rice has not received serious attention in Nigeria, or indeed in the rest of Africa, as a substrate for brewing.

Rice (*Oryza sativa)* is one of the most important cereal of the world. It is produced locally in most part of Nigeria, namely, Abakaliki, Bida, Abeokuta,

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Mokwa, etc where it is used mainly for human consumption. Estimated annual production of rice in Nigeria is about 3 million tonnes (CBN, 1997). *Ofada* rice is the mostly cultivated rice in Nigeria especially in the Southwestern agroecological zone. *Ofada* rice is avialable all year round and can be used as alternative for barley in brewing industies in the country. The use of rice as a superior adjunct for premium quality malt and beer brewing, beverages and wine has been developed (Pomeranz, 1985) but its use as the major substitute for barley to produce malt in Nigeria is scarcely researched. It has been reported that malt produced with rice will have a higher average yield than maize and sorghum(which are normally used in brewing) because of its high carbohydrate content (Pomeranz,1985). Also, amylase content is considered the single most important characteristic for predicting rice cooking and processing behaviour (Juliano, 1985) and will be another major reason for rice to be suitable for malting process. However, since the malting quality of *Ofada* rice is scarcely reported there is the need to investigate the malting characteristics of *ofada* rice as well the chemical and sensory qualities of malt from *Ofada* rice and its combination with other local cereals. The objective of this study therefore was to evaluate the malting characteristics of *Ofada* rice and determine the chemical and sensory qualities of malt from *Ofada* rice and in combination with other local cereals.

## Materials and Methods

*Sources of grains used for the study*

*Ofada* rice, sorghum, and maize grains were obtained from Lafenwa market, Abeokuta, Ogun state, Nigeria. Saccharifying and liquifying enzymes (Fermex, termamyl, amiq, amylase) as well as caramel, hops, sugar were obtained from Vitamalt, Plc, Agbara Industrial Estate, Ogun state, Nigeria.

*Evaluation of malting potentials*

The grains were tested for viability, uninfestation by weevils and adequate moisture content according to recommended methods of analysis (Institutes of Brewing (IOB), 1989). Grains were thereafter steeped for twenty-four hours at 28°C and the water changed every 6-hour. Samples (100g) were germinated at 28°C on Whatmam's N0.1 filter paper (9 cm diameter) inside covered petridishes containing 4 ml and 10 ml distilled water, respectively. The germinated grains were removed and counted at 24, 48, and 72-hours interval. After the grains have germinated the dormancy, germinative energy, capacity, and cold water extract of *Ofada*,sorghum and maize grains were determined according to the method described by Hough *et al.* (1971). Where:

**Dormancy** is the total number of ungerminated grains

**Germinative Energy=**

$$\left(\frac{\%\ \text{viable grains}}{\text{Total number of grain}}\right) \times 100$$

**Germinative Capacity =**
% Germinative Energy - % Dormancy

**Malting Loss =**

$$\left(\frac{\text{weight of grain (unmalted)100g} - \text{weight of grain (malted)}}{\text{weight of grain (unmalted) 100g}}\right) \times 100$$

**Malting Yield=**

$$\left(\frac{\text{weight of grain (malted)100g}}{\text{weight of grain (unmalted) 100g}}\right) \times 100$$

*Cold water extract:* Five grams of grounded malted cereal (grist) was weighed and digested with 100 ml of water mixed with 12 ml of 0.1N ammonia for 3 hours at 28ºC.The solution was stirred at half hour intervals. The solution was filtered using fluted filter paper. The speccific gravity of the filtrate was determined with a specific gravity bottle and the cold water extract was calculated.

**Cold water extract =**

$$\frac{\text{weight of specific gravity bottle} + \text{sample} - \text{weight of specific gravity bottle}}{\text{volume of water}}$$

*Production of malt*

*Germination and cleaning:* Cleaning was done using a sieve to ensure that foreign materials were removed from the graded rice grains, which was washed with distilled water (Okafor and Iwouno, 1990). The cleaned grains were then steeped for 24 - 48 hours, by the end of steeping, the grain had been fully hydrated and then germination proceeded afterwards. The steeped *Ofada* rice was then heaped on a clean floor to germinate for 6-7days. Germination was stopped by kilning at temperature of 48° - 60°C (in the oven) which destroyed some enzymes to a significant level. Milling was done using milling machine (laboratory) to obtain the grist.

*Mashing:* This was done using the digester, the method of mashing using barley was modified as described by Okafor and Iwouno (1990) and was adapted for *Ofada* rice, sorghum and maize grist. The various combinations of the grits (as shown below) were weighed and digested with 330 ml of water at 55°C: 100% Ofada, 50% *Ofada* and 50% Sorghum, 75% *Ofada* and 25% maize, 100% maize, 50% *Ofada* and 50% maize, 75% sorghum and 25% *Ofada*, 100%

sorghum, 75% maize and 25% *Ofada,* 75% Ofada and 25% sorghum. The mixture was then liquefied by adding 0.14 ml of termamyl (a liquefying enzyme) and the temperature was raised to 90 ± 3°C. The pH was adjusted to 6.0 – 6.5 and allowed to rest for 60 min before increasing the temperature to 100°C for 30 min and then cooled to 90°C. Thereafter 0.6 ml of termamyl enzyme was added maintaining the pH at 6.0 – 6.5 and the mixture was allowed to rest for another 30 min at 90°C. The mixture was later cooled to 60°C and pH adjusted to 5.0 – 5.5 (using CaOH). At this temperature and pH, 0.2 ml fungamy (saccharifying) enzyme was added and allowed to rest for 120 min at 60°C for complete saccharification to occur. After complete saccharification, the wort was lautered from the spent grains using mesh sieve and the malting yield was calculated. The wort was thereafter boiled; sugar, caramel and hops were added during boiling. After boiling for 45 min, the malt was cooled to below 4°C and allowed to rest for 3 days to aid separation of trub from the malt which was done using a filter paper to obtain a clear malt that was later bottled and pasteurized at 73°C for 1 hr.

*Determination of chemical composition of Ofada rice, sorghum and maize malt*

The protein content was determined as Kjeldahl nitrogen × 6.25 using the AOAC (1990) method. Starch and sugar contents were determined using the phenol-sulphuric method of Dubois *et al.* (1956). Amylose content was determined according to Williams *et al.* (1970) method. Moisture and fat contents content were determined using AOAC (1990) method.

*Determination of bitterness and Alcohol content*

*Bitterness:* To 20 ml of the wort, was added 22.4ml of trimethyl-pentane and 2 ml of 3N HCl in a flsk. The mixture was agitated for 15min at a revolution of 240 using a shaker. Two layers were obtained, and the less dense liquid was then poured into a cuvette and the bitterness estimated using spectophometer, at a wavelength of 250 nm.

Bitterness at [250nm] = Absorbance reading X 50.

*Alcohol:* To 100 ml of malt in a beaker, 50 ml of distilled water was added and distilled using the distillation apparatus. About 80ml of the distillate was collected and a pycnometer was used to check the specific gravity (S. G.)

Alcohol = S.G X 997.15

*Sensory evaluation*

Malt from *Ofada* rice and different combinations of maize or sorghum were subjected to multiple comparison test and acceptability sensory test. For the multiple comparison, a total of 10 trained panellist was used to assess the degree of difference of the malt samples from Vitamalt™ (control) in terms of aroma, taste, colour, fullness and bitterness. While for acceptability, 30 panellists that were regular malt drinkers were used to signify their acceptability of the malt drinks in terms of aroma, taste, colour, fullness, bitterness and overall acceptability using a 9 point Hedonic scale where 9 represents like extremely and 1 represents dislike extremely.

*Statistical analysis*

All data were subjected to analysis of variance (ANOVA) using SPSS version 15.0 for windows, SPSS inc. Means were separated using Duncan's Multiple Range Test (DMRT).

## Results and Discussion

*Malting characteristics of Ofada rice, maize and sorgum grains*

Table 1 showed the malting characteristics of maize, *Ofada* rice and sorghum grains. The determination of the germinative energy and capacity for barley is to ensure good germination of the grains during malting. Germination is the significant beginning of malting, sorghum has the best malting qualities in terms of Germinative energy (96%), Germinative capacity (92%) and lowest % dormancy (4.67), followed by *Ofada* rice and then maize. For all the three grains, the germinative energy increased with period of germination and was maximum at 72 hours. The germinative energy and capacity obtained for the *Ofada* rice was higher than that obtained for improved rice varieties by Okafor and Iwouno (1990). Also, the germinative energy and capacity obtained for *ofada* rice in this study were almost the same as several varieties of sorghum studied by Okon and Uwaifo (1985). This is indicative of the fact that *Ofada* rice has a high potential in malting. The most important property of any malt is its extract (i.e. the quantity of soluble materials derived from the extract during mashing) (Okafor and Iwouno, 1990). Cold water extract from *Ofada* rice was considerably lower than values obtained from improved rice varieties by Okafor and Iwouno (1990) and sorghum varieties by Okon and Uwaifo (1985). The malting loss of *Ofada* rice was higher than that for sorghum which is presently being used commercially for malting in Nigeria. However,

**Table 1.** Malting qualities (%) of *Ofada* rice, maize and sorgum grains

| Sample | Germinating energy | | | Dormancy | Germinating Capacity | Cold water extract$^{ns}$ | Malting loss | Malting yield |
|---|---|---|---|---|---|---|---|---|
| | 24 hrs$^{ns}$ | 48 hrs$^{ns}$ | 72 hrs | | | | | |
| Maize | 42.33 | 78.00 | 91.67$^{a}$ | 8.33$^{b}$ | 83.33$^{a}$ | 1.000 | 18.34$^{ab}$ | 86.36$^{b}$ |
| *Ofada* | 45.67 | 80.67 | 93.67$^{ab}$ | 6.33$^{ab}$ | 87.33$^{ab}$ | 1.001 | 19.00$^{b}$ | 81.43$^{ab}$ |
| Sorghum | 48.00 | 79.33 | 96.00$^{b}$ | 4.67$^{a}$ | 92.00$^{b}$ | 1.001 | 17.43$^{a}$ | 83.60$^{b}$ |

Values are means of two replicates
Mean values having different superscript within column are significantly different ($p<0.05$)
ns not significantly ($p>0.05$)

**Table 2.** Chemical composition (%) of malt from *Ofada* rice, maize and sorgum grains

| Sample | Dry matter | protein | Fat | Sugar | Starch | Alcohol |
|---|---|---|---|---|---|---|
| 100% *Ofada rice* | 11.01$^{bc}$ | 1.29$^{e}$ | 0.12$^{a}$ | 9.09$^{d}$ | 7.91$^{e}$ | 0.55$^{a}$ |
| 100% maize | 10.80$^{a}$ | 1.26$^{c}$ | 0.28$^{cd}$ | 8.28$_{a}$ | 8.22$^{e}$ | 0.60$^{qb}$ |
| 100% sorghum | 10.82$^{a}$ | 1.35$^{h}$ | 0.32$^{e}$ | 8.75$_{c}$ | 7.14$^{h}$ | 0.60$^{ab}$ |
| 50% *Ofada rice* 50% sorghum | 12.06 | 1.24$^{b}$ | 0.25$^{b}$ | 9.07$^{b}$ | 7.31$^{c}$ | 0.55$^{a}$ |
| 50% *Ofada rice* 50% maize | 11.04 | 1.22$^{a}$ | 0.28$^{cd}$ | 8.44$^{d}$ | 6.95$_{b}$ | 0.65$^{qbc}$ |
| 75% maize 25% *Ofada rice* | 10.94$^{b}$ | 1.33$^{f}$ | 0.30$^{d}$ | 8.79$^{c}$ | 6.49$^{a}$ | 0.60$^{ab}$ |
| 75% *Ofada rice* 25% maize | 10.82$^{a}$ | 1.29$^{d}$ | 0.25$^{c}$ | 9.07$^{d}$ | 7.31$^{c}$ | 0.80$^{bc}$ |
| 75% sorghum 25% *Ofada rice* | 11.04$^{c}$ | 1.34$^{g}$ | 0.28$^{a}$ | 8.28$^{a}$ | 8.22$^{e}$ | 0.85$^{c}$ |
| 75% *Ofada rice* 25% sorghum | 11.01b$^{c}$ | 1.26$_{c}$ | 0.28a | 9.09$^{d}$ | 6.95$^{b}$ | 0.55$^{a}$ |

Values are means of two replicates
Mean values having different superscript within column are significantly different ($p<0.05$)

**Table 3.** Physicochemical properties of malt from *Ofada* rice, maize and sorghum grains

| Sample | pH | colour | Present gravity | Specific gravity | bitterness |
|---|---|---|---|---|---|
| 100% *Ofada rice* | 4.93$^{ab}$ | 210.00$^{b}$ | 12.10$^{a}$ | 0.0006$^{ab}$ | 22.20$^{c}$ |
| 100% maize | 4.91$^{ab}$ | 200.00$^{a}$ | 12.15$^{qbc}$ | 0.0006$^{ab}$ | 24.65$^{b}$ |
| 100% sorghum | 5.06$^{c}$ | 240.25$^{g}$ | 12.13$^{c}$ | 0.0006$^{ab}$ | 20.00$^{q}$ |
| 50% *Ofada rice* 50% sorghum | 5.05$^{c}$ | 231.00$^{f}$ | 12.30$^{c}$ | 0.0006$^{a}$ | 21.58$^{b}$ |
| 50% *Ofada rice* 50% maize | 4.87$^{a}$ | 226.50$_{e}$ | 12.10$^{ab}$ | 0.0007$^{bc}$ | 24.08$^{d}$ |
| 75% maize 25% *Ofada rice* | 4.98$^{bc}$ | 215.00$^{c}$ | 12.10$^{ab}$ | 0.0006a | 23.08$^{d}$ |
| 75% *Ofada rice* 25% maize | 4.87$^{b}$ | 220.25$^{d}$ | 12.05$^{a}$ | 0.0008$^{bc}$ | 24.73$^{f}$ |
| 75% sorghum 25% *Ofada rice* | 5.05$^{c}$ | 200.00$^{a}$ | 12.25$^{bc}$ | 0.0009$^{c}$ | 24.18$^{e}$ |
| 75% *Ofada rice* 25% sorghum | 4.90$^{bc}$ | 200.05$^{a}$ | 12.30$^{c}$ | 0.0006$^{a}$ | 21.50$^{b}$ |

Values are means of two replicates
Mean values having different superscript within column are significantly different ($p<0.05$)

**Table 4.** Multiple comparison of malt from *Ofada* rice, maize,and sorghum grains with Vitamalt™

| sample | aroma | Fullness[ns] | Colour[ns] | Sweetness | bitterness |
|---|---|---|---|---|---|
| 100% *Ofada rice* | 2.4[ab] | 1.5 | 1.6 | 2.4[abc] | 1.8[abc] |
| 100% maize | 2.5[ab] | 1.8 | 1.8 | 2.5[abc] | 2.4[bc] |
| 100% sorghum | 2.3[ab] | 1.6 | 1.5 | 2.0[a] | 1.7[ab] |
| 50% *Ofada rice* 50% sorghum | 2.3[ab] | 1.5 | 1.7 | 2.0[a] | 1.5[a] |
| 50% *Ofada rice* 50% maize | 2.6[ab] | 2.0 | 1.7 | 2.6[abc] | 2.5[c] |
| 75% maize 25% *Ofada rice* | 2.5[ab] | 2.2 | 2.0 | 2.1[ab] | 2.1[abc] |
| 75% *Ofada rice* 25% maize | 1.8[a] | 1.6 | 2.1 | 2.0[a] | 1.8[abc] |
| 75% sorghum 25% *Ofada rice* | 2.4[ab] | 2.0 | 1.8 | 2.7[bc] | 2.4[bc] |
| 75% *Ofada rice* 25% sorghum | 2.3[ab] | 1.8 | 1.6 | 2.8[c] | 2.0[abc] |

Values are means of two replicates
Mean values having different superscript within column are significantly different (p<0.05)
ns not significantly different (p>0.05)

**Table 5.** Sensory acceptability of malt from *Ofada* rice, maize and sorghum grains

| Sample | Aroma | Fulness | Colour[ns] | Sweetness | Bitterness |
|---|---|---|---|---|---|
| 100% *Ofada rice* | 6.43[c] | 6.00[b] | 6.60 | 6.03[bc] | 6.43b[c] |
| 100% maize | 4.53[a] | 5.07[a] | 6.27 | 4.80[a] | 4.97[a] |
| 100% sorghum | 7.53[d] | 7.10[c] | 6.67 | 7.47[d] | 6.83[c] |
| 50% *Ofada rice* 50% sorghum | 5.40[ab] | 5.53[ab] | 6.33 | 5.50[bc] | 5.57[ab] |
| 50% *Ofada rice* 50% maize | 6.07[bc] | 6.30[bc] | 6.33 | 6.33[c] | 6.03[abc] |
| 75% maize 25% *Ofada rice* | 5.80[bc] | 5.87[ab] | 6.43 | 5.63[ab] | 5.40[ab] |
| 75% *Ofada rice* 25% maize | 4.43[a] | 5.37[ab] | 6.33 | 5.40[ab] | 5.47[ab] |
| 75% sorghum 25% *Ofada rice* | 4.40[a] | 5.33[ab] | 6.20 | 5.10[ab] | 5.03[a] |
| 75% *Ofada rice* 25% sorghum | 6.03[bc] | 6.20[bc] | 6.53 | 6.27[bc] | 5.57[ab] |
| Control (Vitamalt™) | 6.60[c] | 6.23[bc] | 6.53 | 5.87[bc] | 5.70[ab] |

Values are means of two replicates
Mean values having different superscript within column are significantly different (p<0.05)
ns not significantly different (p>0.05)

high malting loss in *Ofada* rice can be reduced by the use of other techniques in malting such as the use of gibberellic acid (GA3) which triggers modification of the cereals (Lewis, 1995). Since malting qualities determine the cereals that can be used as substitutes to barley, *Ofada* rice with germination energy of 93.6% and germinating capacity of 87.3% may serve as a substitute for sorghum and barley in malting in Africa. The malting yield is also high due to the low level of moisture content of the cereals.

*Chemical composition of malt from Ofada rice, maize and sorgum grains*

Table 2 showed the results of the chemical composition of the pasteurized malt from *Ofada* rice, sorghum and maize, and their various combinations. The low levels of protein, and fat obtained for all the malted samples were expected since the cereal used are carbohydrate sources with higher levels of sugar (simple sugar) after saccharification process (Lewis, 1995). However, the low fat and protein contents of malt obtain from *Ofada rice* malt are desirable because lipids can destroy foaming capacities of malt and beer (Okafor and Iwouno, 1990). Apart from the advantage of low fat and protein content of rice, another important property which could be an asset in brewing is its possession of husk. These could form a filter bed in a lauter tun during mashing as is the case with barley. Low level alcohol content shows the absence of alcohol in the malt drinks, which is desirable.

*Physicochemical Properties of malt from Ofada rice, sorghum and maize*

Table 3 showed the physiochemical properties of malt from *Ofada* rice, sorghum and maize grains, and their various combinations. There were significant difference (P<0.05) in their specific gravity, and present gravity, *Ofada* rice has the highest Present gravity which defines the strength of the malt. The level of bitterness is due to the quantity of hops (additives) added and this suggests good solubilization and isomerization of (50/50 alpha) hops during wort boiling. It was observed that during filtration *Ofada* and sorghum had slower filtration rates because of their lower Specific gravities. The slower filtration rates of sorghum and *Ofada* worts demonstrated in this investigation agreed with earlier work of Glennie and Wright (1986) which showed that sorghum worts contained higher content of dextrin which impair wort filteration.

***Sensory qualities of malt from Ofada rice, sorghum and maize***

Table 4 showed the result of the multiple comparison test of malt from *Ofada* rice, maize and sorghum with Vitamalt™ (control) while table 5 showed the result of sensory acceptability of the various malt samples. All the malt samples were significantly different (P<0.05) from the control in terms of aroma sweetness and bitterness but were not different in terms of fullness and colour. The malt from 75% *Ofada* rice and 25% maize were very close to the control. Sensory panellist rated malt from 100% *Ofada* rice higher than the control in terms of overall acceptability. Significant differences (P<0.05) existed in all the panellists acceptability scores for the sensory attributes except colour.

## Conclusion

Based on the results obtained in this study *Ofada* rice was observed to have good malting characteristics thus, its high potential as a local substitute in the malting industries. It can also be concluded from the responses of the sensory panelists that malt from *Ofada* rice and its combinations with sorghum and maize were highly rated in terms of sensory parameters (aroma, fullness, colour, sweetness and bitterness), hence *Ofada* rice can be used as an alternative raw material (and also in its combinations with sorghum and maize) in the malting industries.

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