EFFECT OF MANGANESE AND THIAMINE SUPPLEMENTATION ON YEAST ACTIVITY IN BARLEY MALT/MAIZE GRIT WORTS

F.B. AIYELEYE[1] and R.A. OLOYO[2]

[1]Department of Food Technology, [2]Department of Science Lab. Technology, Federal Polytechnic, Ilaro, P.M.B. 50, Ilaro*

ABSTRACT

The effect of replacing malt (grist) with graded levels of (0, 25, 50, 70 and 100 percent maize (grit) and supplementation with 0.0 or 0.5 mg/l thiamine or 0.0 or 5.0 mg/l manganese for mashing and wort production was monitored by the disappearance of glucose from the fermenting liquor over 12 hours. Results obtained indicated that only 25 percent of malt grist could be replaced by maize grit when the wort had no vitamin and mineral supplements. Supplementation of the wort with either thiamine or manganese or both combined increased the replacement level to 75 percent.

INTRODUCTION

Adjuncts which are unmalted carbohydrate materials have been used to replace part of malted barley in beer manufacture[1,2,3] in Nigeria. Yellow maize is a popular adjunct material because of its colloidal stability in beer even at level up to 30% grits. Corn grits are however lower in thiamine and manganese contents than barley and when used to replace high level of barley malt may influence the performance of yeast in degrading sugar to alcohol[4,5]. This study was undertaken to determine the effect of thiamine and manganese addition to maize adjuncted barley grist.

MATERIALS AND METHODS

The grist, grit as well as yeast (*Saccharomyces carls-bergensis*) used in this study were obtained from Sona Breweries Limited, Ota, Ogun State. The cereal samples were stored in air-tight containers while the activity of the yeast was arrested by keeping at a temperature below 4°C until they were needed for experimentation. Thiamine hydrochloride was obtained from FARMEX Limited, Sango Ota, Ogun State while manganese sulphate (Analar grade) served as the manganese source.

---

*Paper accepted February, 1999

Prior to use, samples of the cereals were milled and then analysed for moisture, total nitrogen and fat in accordance with the procedures of AOAC[6] and IOB[7]. Crude protein was calculated as total nitrogen multiplied by 6.25. Total carbohydrate was obtained by difference.

Five different combinations of grist and grit were made such that partially heated maize grit replaced malted barley (grist) at 0, 25, 50, 75 and 100% levels. Duplicate samples (10g) of each of these were mashed with 100ml distilled water at 45°C using the Double Mash System[8]. The mash was then filtered hot and the presence of reducing sugar in the resulting wort tested quantitatively with Fehling's solutions.

Worts obtained from the five different grist-grit combinations were supplemented with thiamine (0 and 0.5mg/l) and manganese (0 and 5.0mg/l) in a 2 x 2 x 5 factorial treatment combinations. Each of the treated wort was pitched with yeast (1%) and fermentation continued for 12 hours. Rate of fermentation was monitored by the disappearance of glucose[9] in the sample drawn from the fermentation tank at time zero and subsequently at one hour interval over the fermentation period.

RESULTS AND DISCUSSION

The proximate composition of the maize grit and the malt grist used for wort production (Table 1) indicated that yellow maize compared favourably with malted barley., and that it has values close to those reported by Food and Agricultural Organization[10]. Table 2 shows the chemical composition of the wort produced from the different malt-maize combinations. The total solids in wort increased with increase in the proportion of maize in malt-maize combinations. The values ranged from 94.6% when maize was 0% in the combination to 96.3% when it was 100%. Also, total nitrogen, ash and lipids increased when the proportion of maize in the combination increased. The Master Brewers Association of the Americas, MBAA[2] reported that the higher the adjunct ratio, the lower the wort nitrogen. The lipids of worts with adjuncts ranged between 0.03 and 0.06%. This is because the malt grist is richer in these nutrients than maize grit[11].

The effect of manganese and/or thiamine supplementation on fermentation rate is presented in Table 3. Rate of disappearance of glucose from the wort, an index of fermentation rate, showed that in the absence of supplemental manganese and thiamine, fermentation proceeded at slow rate in each of the worts produced from all the malt-maize combinations. The rate became rapid

with the supplementation of either of the two nutrients or a combination of both. When the supplements were added singly, slightly higher rate of fermentation was observed with manganese than with thiamine. The highest fermentation rate was achieved with the supplementation of a combination of both nutrients.

Table 1: Proximate Composition of Maize Grit and Malt Grist Used for Wort Production

Chemical constituent (%)	Malt grist	Maize grit	FAO std*
Moisture	10.01	22.5	-
Dry matter	89.98	88.5	-
Crude protein	10.40	9.80	10.0 - 12.3
Ash	2.50	1.20	2.1 - 3.1
Ether extract	1.50	0.90	1.4 - 2.4
Total carbohydrate	78.40	72.00	75.0

Table 2: Chemical Composition of Worts Produced from Different Combinations of Malt Grist-maize Grit

Malt-maize combination	Total solids (%)	Ash (%)	Total nitrogen	Total lipid (%)
100% Malt + 0% Maize	94.60	1.60	0.27	0.005
75% Malt + 25% Maize	95.00	1.52	0.24	0.004
50% Malt + 50 Maize	96.55	1.43	0.23	0.004
25% Malt + 75 Maize	96.03	1.39	0.22	0.003
0% Malt + 100% Maize	96.28	1.20	0.19	0.001

These results are in agreement with the assertion that yeast has high affinity for divalent metal ions[5]., and that the activities of actively growing yeast was greatly improved in the presence of 0.5mg/l thiamine hydrochloride and some other vitamins in addition to customary nitrogen, carbon and mineral sources[4]. The enhancement in the rate of fermentation obtained with the addition of both manganese and thiamine at the levels used in this work (Table 3) also seemed to confirm earlier report on the synergistic effect of both nutrients on the maintenance of active yeast activity. Indeed, fermentation of wort by *Saccharomyces spp* is a process involving the catabolism of various sugars to produce alcohols, carbon dioxide, esters, aldehydes and other flavour components[12, 13]., and that coenzyme functions have been described for thiamine and manganese in the process[14]. The improved fermentation rates observed in worts supplemented with thiamine and manganese might be due to either the enhancement of the level of the vitamin and mineral originally present in the wort and/or the metabolic roles (cofactors for enzymes) played by these two supplements in biochemical reactions leading to the production of ethanol.

Table 3: Effect of Thiamine (B_1) and Manganese (Mn) Supplementation of Fermentation Rate as mg glucose/litre/hour

Wort produced from malt/maize combination	0.0 mg B_1		0.5 mg B_1	
	0.0 mg Mn	5.0 mg Mn	0.0 mg Mn	5.0 mg Mn
100% Malt	0.036	0.046	0.050	0.056
75% Malt + 25% Maize	0.034	0.042	0.048	0.058
50% Malt + 50% Maize	0.020	0.025	0.030	0.045
25% Malt + 75% Maize	0.028	0.041	0.047	0.058
100% Maize	0.010	0.018	0.028	0.030

Furthermore, results in Table 3 showed that in case of supplementation of worts with thiamine and manganese, rates of fermentation in worts produced from 100% malt were close to fermentation rates observed in worts from 75% malt and 25% malt in the mixtures respectively. Similar rates of fermentation were observed for worts produced solely from malt and those containing 75% malt + 25% maize combination. These results seemed to indicate that malt grist could be replaced with maize grit up to 75% when wort is supplemented with 0.5mg/l thiamine and 5.0mg/l manganese whereas, 25% replacement level could be achieved without supplementation of the nutrients.

REFERENCES

1. Bradee, L.H. (1974) Composition of the grist. MBAA Technical Quarterly 2 (1) 57-62.
2. Bradee, L.H. (1977) Adjuncts in 'The Practical Brewer' Ed. H.M. Broderick, Publisher Master Brewers Association of the Americas. Madison, Wisconsin 53705 pp 40-61.
3. Brenner, M.W., Arthurs, M.J., and Stewart, E.E. (1968). Yellow corn grits Vs brewers corn syrups as adjuncts for larger beer. MBAA Technical Quarterly. 5(1) 30-38.
4. Hsu, W.P., Vogt, A., and Bernstein, L. (1980). Yeast nutrients and beer quality. MBAA Technical Quarterly 17 (2) 85-88.
5. Saltukoglu, A., and Slaugher, J.C. (1983). The effect of magnesium and calcium on yeast growth. J. Inst. Brew. 89; 81-83.
6. AOAC (1970) Official Methods of Analysis of the Association of Official Analytical Chemists, Washington, D.C. 13th ed.
7. IOB (1972). Recommended Methods of Analysis of the Institute of Brewing. Reprinted ed.
8. Briggs, D.E., Hough, J.S., Stevens, R. and Young, T.W. (1981). Adjuncts, sugars, wort syrups and industrial enzymes in 'Malting and Brewing Science' Vol. II. Hopped Wort and Beer. Chapman and Hall, London.
9. Dubois, M., Gillies, K., Hamilton, J.K., Robers, P.A., and Smith, F. (1956). Calorimetric method for determination of sugars and related substances, Anal. Chem. 28, 350-356.
10. FAO (1979). Food and Agricultural Organization of the United Nations. Agric. Dept. Production Year Book. pp 33.
11. Hough, J.S., Briggs, D.E., Stevens, R. And Young, T.W. (1982). Metabolism of Wort by Yeast (Nutritional requirement) in 'Malting and Brewing Science'. Vol. II: Hopped wort and Beer. Chapman and Hall, London.

12. Piper, J.U. (1978). Pathway to control of brewing fermentation. MBAA Technical Quarterly. 15, 8.
13. Ruocco, J.J., Coe, R.W., and Hahn, C.W. (1980). Computer assisted exotherm measurement in full-scale brewery fermentation. MBAA Technical Quarterly, 17 (2) 69-76.
14. Braunlich, K., and Zintzen, H. (1976). Vitamin B_1 in Animal Nutrition. Information Service. Basle. Hoffman-La Roche.