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EFFECTS OF PROCESSING METHODS ON THE MALONALDEHYDE CONTENT OF SOME CEREALS

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ABSTRACT

The effects of some processing methods on the malonaldehyde (MDA) content of selected cereals were investigated. MDA content of the green malt of the cereals investigated increased. Percentage increases ranged from 13.9± 0.06% in maize – Suwan ISR-Y to 195.8 ± 101% in millet – Pearl. Kilning of the green (finished malt) also increased the MDA content of the cereals. Percentage increases ranged from 77.2±32.9% in wheat to 421±67.7% in maize- Obubra Local. Roasting of the cereals also increased their malonaldehyde contents .7.2±10.1% in maize – Suwan ISR-Y. The highest increase of 104.4±42 5% was recorded in maize – Obubra Local. Steeping of the cereals in water followed by roasting decreased the MDA content. Percentage decreases ranged from 25±35.4% in millet – Pearl to 65.3±11.2% in maize – Suwan ISR –Y. Fermentation progressively reduced the MDA content of the cereals investigated. After 3 days of fermentation the MDA content was reduced. Reduction ranged from 71.3±0.0% in sorghum - ICSV 400 to 96.7±4.6% in maize – Suwan ISR-Y. These findings show that processing affects the MDA concentration of cereals. While malting and roasting increased the MDA content; steeping /roasting and fermentation reduced the MDA content.

KEYWORDS: Malonaldehyde contents, cereals, processing.

INTRODUCTION

Malonaldehyde (MDA) is a major decomposition product of peroxidized polyunsaturated fatty acids (Shamberger, *et al*. 1997. Ononogbu. 2002; Iwe. 2003). Malonaldehyde in lipid – containing foods is generally associated with oxidative rancidity (Sinnhuber and Yu, 1958; Koning and Silk, 1963; Ononogbu, 2002).

Interest in the possible significance of malonaldehyde in human health has been stimulated by reports that it is mutagenic (Mukai and Goldstein, 1976; Yau, 1979; NIOSH, 2005) and carcinogenic (Shamberger *et al*; 1974; Siu and Draper, 1978; Spalding, 1988). There is evidence that malonaldehyde cross-links with amino groups of deoxyribonucleic acid (DNA) through the formation of Schiff-base which suggests the basis for its mutagenicity (Mukai and Goldstein, 1976). MDA-deoxyguanosine adducts have been detected in human liver (Chaudhary *et al*; 1994). This suggests the need to carry out a survey to determine components of our diet with high risk of exposure to MDA.

In this study, the effects of malting, roasting, steeping and roasting and fermentation on the MDA content of some cereals were investigated. This study will provide not only an indication of mean MDA contents of common dietary cereals but also effects of processing on the MDA contents.

MATERIALS AND METHODS

Plant Materials

Maize, *Zea mays*, (Obubra Local and Suwan ISR-Y) were got from National Cereal Research Institute (NCRI), Amakama, Umuahia, Abia State, Nigeria; millet, *Pennisetum typhoides*, (Pearl) was got from International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria; while sorghum, *Sorghum vulgare*, (ICSV 400 and KSV 8); and wheat, *Triticum vulgare* were got from Ahmadu Bello University Agricultural Research Centre (National Seeds), Zaria, Kaduna State, Nigeria.

Malting

The grains were steeped in distilled water in 1:2 (grain to water) w/v ratio for 24hr and the water changed every 6hr. After steeping, the grains were sterilized with diluted hypochloric acid solution (1:10 dilution). They were then germinated on a moist grain bed for 72hr. The green malt produced was kilned for 24hr at 55° C in a regulated oven to produce the finished malt.

Roasting

The grains were put in a regulated oven for 24hr at a temperature of 110° C.

Steeping and Roasting

The grains were soaked in distilled water in 1:2 (grain to water) w/v for 24hr and the water changed every 6hr. After steeping the grains were kilned in an oven for 24hr at 110° C.

Fermentation

Fermentation was carried out using the method described by Iwuoha and Eke (1996) with minor modifications with regards to duration of fermentation, which lasted 3 days in their method. The grains were soaked in distilled water for 1 day. The soak water was drained and the grains germinated for 2 days and sun dried for 2 days. The grains were milled into flour, mixed with 100ml of water and heated for 2hr at 50° C – 60° C. The slurry was pasteurized at 100° C for 1 hr. The mixture was allowed to stand at room temperature for 24hr. More water (50ml) was added and yeast (*Saccharomyces cerevisae*) inoculated and allowed to ferment for 3 days.

Determination of MDA content

The malonaldehyde contents of samples were determined by the thiobarbituric acid (TBA) reaction with minor modification of the method of Heath and Packer (1968). A 0.25g ground sample was homogenized in 5ml of 0.1% Trichloroacetic acid (TCA). The homogenate was centrifuged at 10,000g for 5min. To 1ml aliquot of the supernatant 4ml of 20% TCA containing 0.5% TBA were added. The mixture was heated at 95° C for 30 min and then quickly cooled in an ice bath. After centrifuging again at 10,000g for 10min the absorbance of the supernatant at 532nm was read and the value for the non-specific absorption at 600nm was subtracted. The concentration of MDA was calculated using a standard curve.

A standard curve was constructed using the MDA derivative 1, 1, 3, 3-tetramethoxypropane (TMP) (Sigma-Aldrich Chemical Co.), which hydrolyzes under acid conditions to form free dialdehyde.

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RESULTS

All the cereals used had varying concentrations of MDA in the unprocessed forms as shown in Table 1. Malting affected the MDA content of the cereals by increasing the MDA concentration of the cereals as summarized in Fig. 1. Green malting increased the MDA concentration by 13.9± 0.7% in maize – Suwan ISR-Y to 195.1 ± 101% in millet-Pearl. In finished malt, the MDA content increased by 77.2 ± 32.9% in wheat to 421.± 67.7% in maize-Obubra Local

Roasting increased the MDA content in all the cereals investigated (Table 1). It increased the MDA contents by 7.2±10.1% in maize – Suwan ISR-Y to 104.4 ± 42.5% in maize – Obubra Local. Conversely, steeping and roasting (Table 1) and fermentation (Fig. 2) reduced the MDA content in all the cereals by 25.0 ± 35.3% in millet – Pearl to 65.3 ± 11.2% in maize – Suwan ISR –Y. After 3 days of fermentation, the MDA contents of the cereals were reduced by 71.3 ± 0.0% in sorghum – ICSV 400 to 96. 96.7 ± 4.6% in maize-Suwan ISR-Y

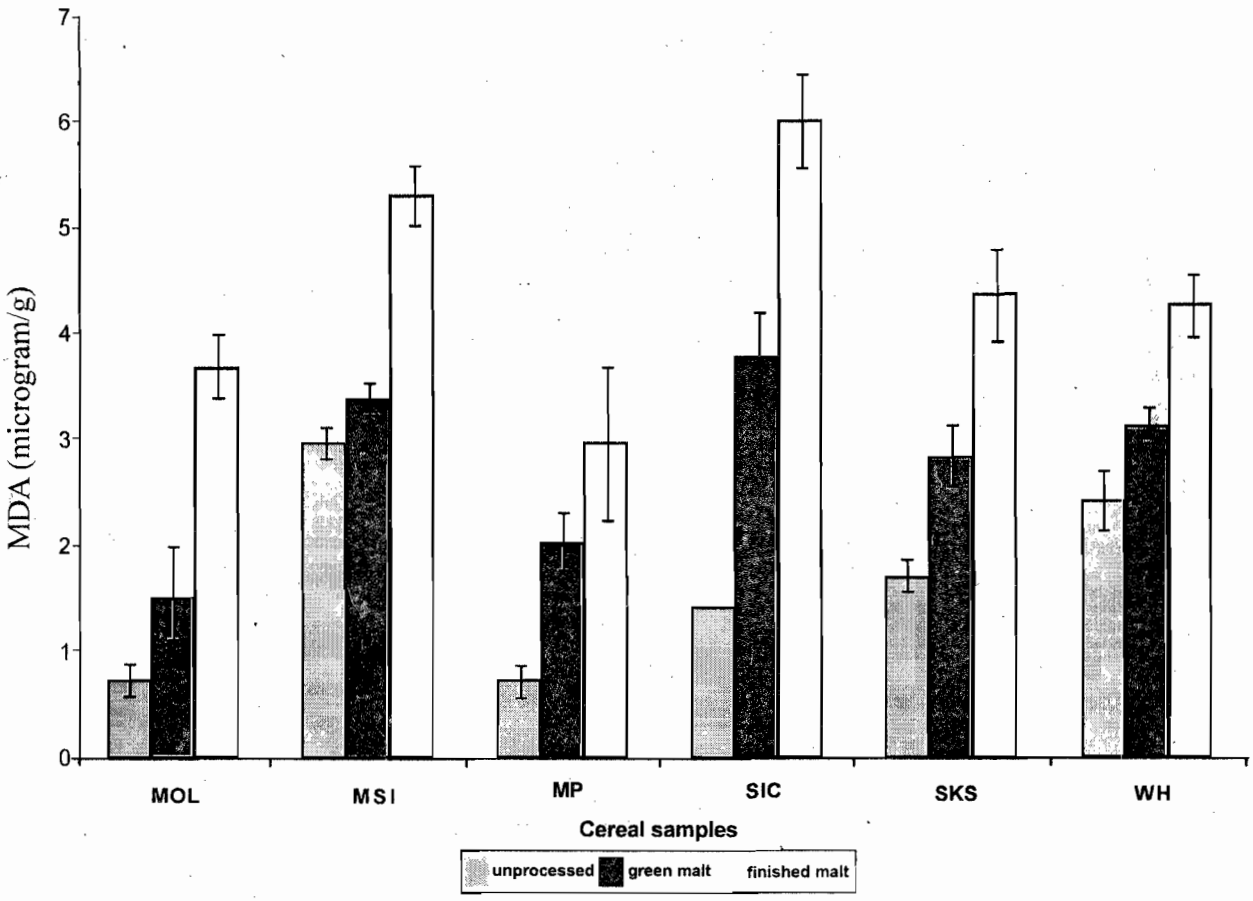

Fig 1: Effect of malting on MDA of cereals

MOL – Maize – Obubra Local
MSI – Maize – Suwan ISR-Y
MP – Millet – Pearl
SIC – Sorghum – ICSV 400
SKS –Sorghum – KSV 8
WH – Wheat

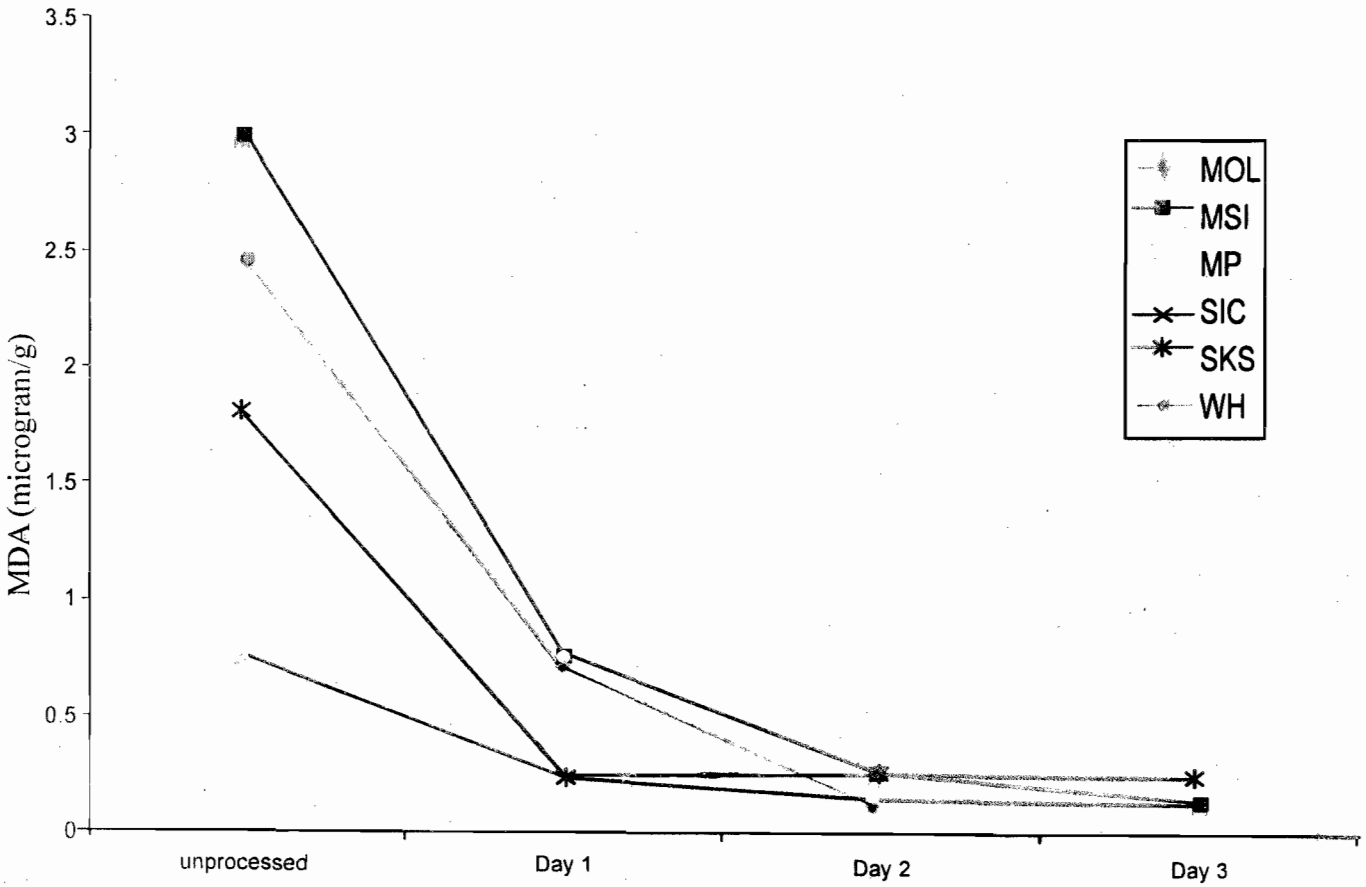

Fig 2: Effect of fermentation on the MDA of cereals

MOL – Maize – Obubra Local
MSI – Maize – Suwan ISR-Y
MP – Millet – Pearl
SIC – Sorghum – ICSV 400
SKS – Sorghum –KSV 8
WH – Wheat

Table 1:Malonaldehyde contents of raw, roasted and steeped/roasted cereal grain flours

	MDA (µg/g ± SD)		
Cereal	Unprocessed	Roasted	Steeped / roasted
Maize – Obubra Local	0.72 ± 0.15	1.43 ± 0.00	0.31 ± 0.15
Maize – Suwan ISR-Y	2.96 ± 0.14	3.17 ± 0.15	1.02 ± 0.28
Millet	0.72 ± 0.15	1.53 ± 0.14	0.51 ± 0.14
Sorghum – ICSV 400	1.43 ± 0.00	2.35 ± 0.15	0.61 ± 0.00
Sorghum – KSV 8	1.74 ± 0.15	2.45 ± 0.29	1.12 ± 0.14
Wheat	2.45 ± 0.29	2.66 ± 0.29	1.43 ± 0.29

Values are Means ± standard deviations of duplicate determinations.

DISCUSSION AND CONCLUSION

The results presented here show varying concentrations of MDA in the unprocessed cereals ranging from 0.72 ± 0.15µg/g in maize – Obubra Local to 2.96 ± 0.14 µg/g in maize – Suwan ISR-Y (Table 1).

Green malting increased the MDA levels in all the cereals investigated. The MDA levels were further increased by kilning of the green malt (Fig.1). Roasting of the cereals also increased their MDA contents (Table 1). These increased levels of MDA are thought to be due to the synthesis of the malt enzymes namely lipase (triacylglycerol acylhydroslase), lipoxidase (lipoxygenase), and hydroperoxide isomerase during germination, which are involved in lipid oxidation (Baxter, 1982; Letters, 1992; Nwanguma et *al*, 1996) and due to the thermal oxidation during kilning of the green malt and roasting of the cereals

Steeping and roasting as well as fermentation reduced the malonaldehyde content of all the cereals (Table 1 and Fig2). The decreased levels of MDA observed in steeped and roasted cereals may be as a result of leaching of the MDA by the steep liquor as has been reported by Elezuo (1996). The decreased levels of MDA in fermented cereals may be due to the utilization of the lipids in the slurry by the yeast cells used for fermentation. As wort nutrients, lipids are essential for the growth, metabolism, and viability of yeast cells (Letters, 1992). This is because the yeast cell membranes require the presence of lipids to be able to absorb nutrients from the wort. In addition, the presence of lipids also endows yeast cells with the important property of ethanol tolerance (Bamforth, 1986; Letters, 1992).

In conclusion, our results suggest that processing affects the malonaldehyde content of cereals. The significances for human health of any of these reported concentrations of MDA in cereals in unknown, but reports that this substance is mutagenic and carcinogenic emphasize the desirability of reducing the concentrations through processing.

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