

Changes in Malonaldehyde Content of Some Roasted Legumes

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ABSTRACT

The effect of roasting alone or steeping of grains before roasting on malonaldehyde (MDA) contents of some legumes was investigated. The legumes studied were Beni seed (*Sesamum indicum*), African bread fruit (*Treculia Africana*), Cowpea (*Vigna unguiculata*), Ground bean (*Vigna subterranea*), Ground nut (*Arachis hypogea*), Local yam bean (*Stenostylis stenocarpa*), Locust bean (*Cerotonia siliquia*), and Soy bean (*Glycine max*). Roasting alone prior to steeping significantly ($p \leq 0.05$) increased the MDA contents in all the legumes. This increase ranged from $8.79 \pm 4.29\%$ in cowpea-Ife brown to $140.20 \pm 56.84\%$ in cowpea L-25. Steeping before roasting resulted in a significant decrease in MDA contents in the legumes ranging from $33.02 \pm 14.14\%$ in Beni seed to $63.11 \pm 32.39\%$ in cowpea L-25. These findings indicate that steeping before roasting may be a safer and more desirable way of processing these legumes given the growing reports about mutagenicity and carcinogenicity of MDA in animal models.

Keywords: Legumes, roasting, steeping, malonaldehyde.

INTRODUCTION

In Africa, especially in Nigeria, traditional processing methods such as roasting constitute a major process of food preservation. In most cases cereals and grains are harvested sun-dried and roasted. They may be used as snacks or ground for the preparation of various porridges. Research evidence has shown that legumes constitute a major source of dietary proteins in Africa (Onuorah *et al*, 1989). Legumes have relatively higher lipid levels than most other food classes (Apata and Ologhobo, 1994). During storage lipids contained in these legumes may undergo lipid peroxidation. One of the products of lipid peroxidation has been shown to be malonaldehyde (MDA) ($\text{CHO CH}_2 \text{CHO}$) is a major decomposition product of peroxidized polyunsaturated fatty acids (Shambergher, Shambergher and Wills, 1977).

Interest in the possible significance of malonaldehyde to human health has been stimulated by reports that it is mutagenic (Mukai and Goldstein, 1976, NIOSH, 2005) and carcinogenic (Spalding, 1998). Brooks and Klamerth (1968) reported that MDA reacts with deoxyribonucleic acid (DNA) indicating a possible rationale for its mutagenic effects. Further evidence that MDA could be mutagenic was provided by Mukai and Goldstein who demonstrated that MDA forms cross-links with amino groups of DNA through a Schiff base. MDA-deoxyguanosine adducts have been detected in human liver by Chaudhary *et al* (1994). The major adduct formed with DNA is the highly fluorescent cyclic N-1,N-2 malonaldehyde-

deoxyguanosine -MDA (Singh *et al*, 2001). The MDA adduct formed has a potential to ultimately lead to liver carcinogenesis.

The aim of this study was to identify processing methods by which MDA contents of legumes could be reduced making them safer for human consumption. In this report the scope covers the comparative effect of (i) roasting or (ii)steeping before roasting on the MDA content of nine legumes.

MATERIALS AND METHODS

Plant Materials

Beni seed (*Sesamum indicum*), African bread fruit (*Treculia africana*), Cow pea-Ife brown and L-25 (*Vigna unguiculata*), Ground bean (*Vigna subterranea*), Ground nut (*Arachis hypogea*), Local yam bean (*Stenostylis stenocarpa*), Locust bean (*Cerotonia siliquia*), and Soy bean-TGX 1448 (*Glycine max*) were obtained from International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria and Ahmadu Bello University Agricultural Centre (National Seeds) Zaria, Nigeria.

Treatment

Raw Samples

The seed samples obtained were cleaned by winnowing of their chaff and freed of stone and other impurities.

Roasting

Stone-free and clean samples were placed in an oven and heated to 110°C for 24hrs. The samples were milled and packaged in air-tight containers.

Steeping and Roasting

Clean samples of the grains were soaked in dis-

tilled water (1:2 grain to water v/v) for 24hrs. During steeping the water was changed every 6hrs to avoid microbial growth. The steeped grains were drained and placed in oven. They were heated to 110°C for 24hrs. These grains were termed steep-roasted samples.

Determination of MDA Content of Legumes

Malonaldehyde contents of raw, roasted, and steep-roasted samples were determined by the thiobarbituric acid (TBA) method as modified by Heath and Packer (1968). Ground sample (0.25g) was homogenised in 5ml of 0.1% trichloroacetic acid (TCA). The homogenate was centrifuged at 10,000g for 5mins. An aliquot of the supernatant (1.0ml) was mixed with 4.0ml of 20% TCA containing 0.5% TBA. The mixture was heated for 30mins and then quickly cooled in an ice bath. It was then centrifuged at 10,000g 10mins. The absorbance of the supernatant was read at 532nm and value for non-specific absorption was also read at 600nm and subtracted. The MDA was calculated from a standard curve constructed using the MDA derivative 1,1,3,3-tetra methoxypropane which hydrolyses under acid conditions to form free dialdehyde.

Analysis of Data

Treatment data were subjected to analysis of variance (ANOVA) and significant differences among treatment means were obtained at 0.05 probability level. The analysis was carried out using Genstat Discovery Edition 1.

RESULTS AND DISCUSSION

Fig 1 shows the malonaldehyde contents of raw,

Table 1. Percentage increase /decrease in Malonaldehyde contents($\mu\text{g/g}$) of processed

| Legume | Raw | Roasted (% \uparrow) | Steep-Roasted (%) |
|---------------------|-----------------|---|--|
| Beni seed | 2.76 \pm 0.15 | 3.98 \pm 0.15 (44.84 \pm 12.94) | 1.84 \pm 0.29(-) 33.02 \pm 14.14) |
| Bread fruit | 6.63 \pm 0.14 | 7.45 \pm 0.15 (12.42 \pm 4.53) | 4.29 \pm 0.87(-) 35.50 \pm 11.75) |
| Cowpea-Ife Brown | 3.47 \pm 0.00 | 3.78 \pm 0.15 (8.79 \pm 4.29) | 2.25 \pm 0.29(-) 35.30 \pm 11.75) |
| Cowpea- L25 | 1.23 \pm 0.29 | 2.86 \pm 0.00 (140.20 \pm 56.84) | 0.41 \pm 0.29(-) 63.11 \pm 32.39) |
| Ground bean | 3.17 \pm 0.43 | 3.88 \pm 0.29 (22.81 \pm 7.80) | 1.64 \pm 0.29(-) 48.49 \pm 2.14) |
| Ground nut | 1.94 \pm 0.14 | 2.55 \pm 0.14 (31.53 \pm 2.30) | 0.92 \pm 0.43(-) 53.53 \pm 18.84) |
| Local yam bean | 1.94 \pm 0.14 | 2.55 \pm 0.14 (31.53 \pm 2.30) | 0.92 \pm 0.43(-) 53.53 \pm 18.84) |
| Locust bean | 3.47 \pm 0.00 | 4.07 \pm 0.29 (17.73 \pm 8.35) | 2.25 \pm 0.29 (35.30 \pm 8.36) |
| Soybean – TGX 1448E | 4.70 \pm 0.29 | 5.21 \pm 0.15 (10.98 \pm 3.69) | 2.25 \pm 0.29 (51.90 \pm 9.15) |

roasted and steep-roasted legume samples, while Table 1 shows the percentage increases or decreases following roasting (only) and steeping before roasting.

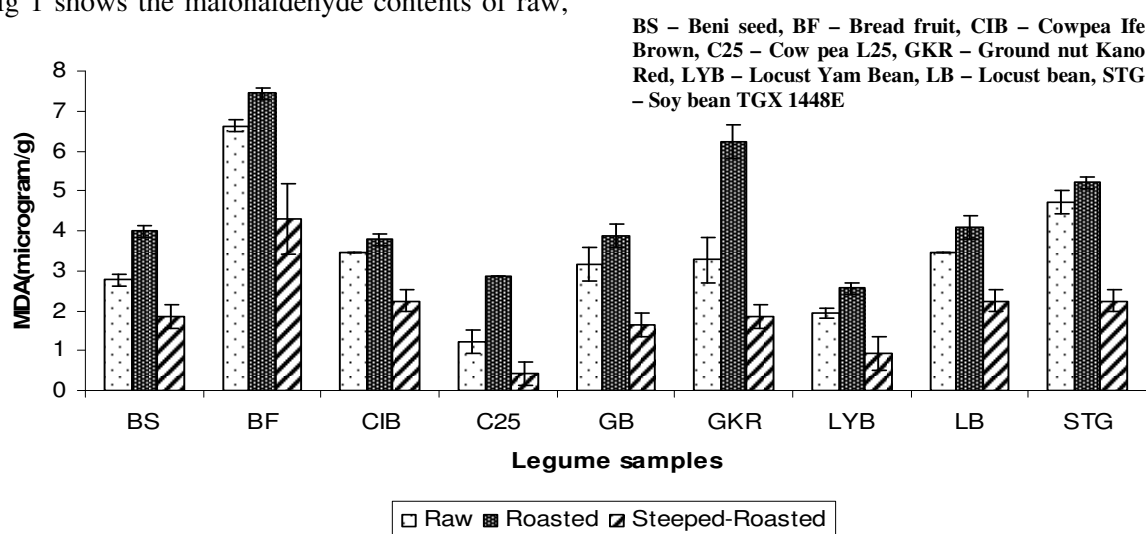


Fig 1: MDA content of raw, roasted and steeped-roasted legumes

Roasting without steeping was found to increase the MDA concentration in all legumes samples studied. Steeping before roasting caused a decrease in MDA contents of all legumes. Increase in MDA content following roasting was highest in cowpea-L25 variety and lowest in cowpea-Ife brown variety. The most substantial reduction in MDA content of steeped and roasted samples was observed in cowpea-L25 while the least decrease was observed in Beni-seed.

The observed increase in MDA content of roasted samples may be due to thermal oxidation. Higher temperatures favour thermal oxidation reactions. The decreased contents of MDA of steeped and roasted samples might have resulted from leaching of malonaldehydes into the steep liquor. Elezuo (1996) reported the presence of MDA in steep liquor during malting of sorghum grains. The practice of steeping before roasting legume seeds could reduce the malonaldehyde contents making them safer for human consumption. Purity analysis by ultraviolet spectroscopy have established that sodium salt of malonaldehyde could be stable for up to 2years when stored at 20°C (Spalding,1988). It is not known yet whether this stability could occur *in vivo* but it has been established to have higher affinity for adenine and cytosine deoxy nucleotides (Singh *et al* 2001). It is metabolized *in vivo*. It is metabolized *in vivo* and *in vitro* by oxidation to malonic semialdehyde and by decarboxylation to acetaldehyde (NIOSH, 2005). The later has also been established as having a potential for DNA adduct formation hence *in vivo* metabolism of MDA may lead to formation of other biologically toxic compounds.

The significance for human health of the concentration of MDA reported in this study is unknown, but it is known that accumulation of DNA adducts in tissues could lead to mutagenicity and carcinogenicity. The desirability of minimizing the occurrence of MDA in foods through improved processing cannot be over emphasized.

REFERENCES

- Apata, D.F and Ologhobo A.D. (1994) Biochemical evaluation of some Nigerian legume seeds. *Food Chemistry* 49: 333-338
- Brooks B.R and Klameth O.L (1968) Interaction of DNA with bifunctional aldehydes. *European Journal of Biochemistry* 5:178
- Chaudhary A.K., Nokubo, Reddy, G.R.,Yiola, S.N., Murrow, J.O., Blair, I.A and Marnett, L.J (1994) Detection of endogenous malonaldehyde-deoxyguanosine adducts in human liver. *Science* 265:1580-1582
- Elezuo E.O (1996) Effects of mashing temperature on malonaldehyde content of sorghum worth. Project report submitted to the Department of Biochemistry University of Nigeria Nsukka, Nigeria.
- Heath, R.N and Packer, H (1968) Photoperoxidation in isolated chloroplasts. Kinetics and stoichiometry of fatty acid peroxidation. *Archives of Biochemistry and Biophysics* 125:189-198
- Mukai, F.H and Goldstein B.D (1976) Mutagenicity of malonaldehyde a decomposition product of peroxidized polyunsaturated fatty acids. *Science* 191: 868
- NIOSH (2005) Carcinogenicity of Acetaldehyde and Malonaldehyde, and Mutagenicity of related low-molecular weight aldehydes. Publication of Current Intelligence Bulletin 55. National Institute for Occupational Safety and Health.
- <http://www.cdc.gov/mmwr/preview/mmwrhtml/001626.htm> Accessed March 10, 2005.
- Onuorah, V.I., Uwaegbute, A.C and Enwere, N.J (1989) Cowpea utilization and (Practical). In Food crops production, utilization and nutrition. Mbah, M.B and D.O Nnayelugo (Eds). Dotam Publications Ltd, Ibadan. pp 121-126
- Shamberger, R.J., Shamberger, B.A and Wills C.E (1997) Malonaldehyde content of food. *Journal of Nutrition* 107: 1404-1409.
- Singh, R., Leuratii, C.,Joysuta, S., Sipowicz, M.A.,Diwan,B.A., Kasprzak, K.S., Schut, H.A., Marnett, L.J., Anderson, L.M and Shuker, D.E.G (2001) Lobe-specific increases in malonaldehyde DNA adduct formation in the livers of mice following infection with *Helicobacter hepaticus*. *Carcinogenesis* 22(8): 1281-1287.
- Spalding, J.W. (1988) Toxicology and Carcinogenesis studies of malonaldehyde sodium salt (3-hydroxy-2-propenal, sodium salt) (cas No.24382-04-5) in F344/N rats and B6C3F1 mice (Gavage studies) NTP Technical Report 331. Research Triangle Park, Park, NC: National Toxicology Program,5-13.