Food Chemistry **14** (1984) 157–165

Malonaldehyde Content of Indigenous and Imported Foods and Foodstuffs in Nigeria

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(Received: 7 November, 1983)

ABSTRACT

Several types of imported and locally available foods and foodstuffs in Nigeria were analysed for their malonaldehyde concentrations. The malonaldehyde levels of imported canned fish products ranged from 0·32 to 3·32 mg/kg. Thermal treatment of mackerel (Scomber scombus) *reduced its malonaldehyde level but increased the oncogenic substance of other fish samples. Freezing beef for 4 days increased the malonaldehyde level with a mean of 0·48 mg/kg. The extract from boiled liver had a higher malonaldehyde level than that from raw liver. Milk and milk products did not contain any detectable quantity of malonaldehyde. The need to determine the cumulative effect(s) of ingesting small quantities of malonaldehyde for long periods and further appraisal of all food items for this oncogene are discussed.*

INTRODUCTION

The past decade has witnessed the creation of more capital towns and increased urbanization in Nigeria and a high dependence of the people in

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Food Chemistry 0308-8146/84/$03·00 © Elsevier Applied Science Publishers Ltd, England, 1984. Printed in Great Britain

the urban areas on pre-processed, cooked or uncooked varieties of imported food products known to be handy, appetite appealing, easy to use and time-saving. In spite of the preservative measures aimed at prolonging the shelf-lives of these processed foods, those that are oily in nature or packed in oils are known to deteriorate in value with time due to the rancidity consequent upon poor storage. Consequently, malonaldehyde and/or substances related to it are produced from the decomposition of peroxidized polyunsaturated fatty acids.

In view of the increasing evidence of the adverse physiological properties of malonaldehyde with regard to its carcinogenicity and mutagenicity, the growing evidence on its presence in a number of food items, the ever-increasing rate of importation of food items into the country and the paucity of information on the levels of malonaldehyde in these imported foods and locally available foods and foodstuffs, this study was undertaken to screen these food items for the oncogenic substance.

MATERIALS AND METHODS

Sources of foods and foodstuffs

All canned food items were purchased largely from supermarkets by random selection of each brand from stock. Similarly, all the local foods and foodstuffs investigated were purchased from local markets, street traders or from villagers when such items were not readily available in Ilorin, the capital of Kwara State of Nigeria.

Fish and fish products

The fish and fish products investigated were Rex in soya oil, Alerta in vegetable oil, Hot Titus in spiced oil, Isabel in olive oil and other products in unspecified oil(s). Other fish products were Geisha (mackerel in tomato sauce), some locally processed fish obtained from Dr Dapo Afolabi of the University of Ife, Ile-Ife, Nigeria, and Sarzan (mackerel in salad and soya oil).

Meat and meat products

Some brands of corned beef and sausages analysed included Morey, Unipyrenes, Kondor, Torero and 'bush meat' (smoked grasscutter). Local beef and liver samples from various sources were also investigated.

Milk and milk products

These included fresh milk—'Wara' (locally coagulated milk), cheese and imported and local varieties of yoghurt. Other products studied included some brands of imported evaporated milk such as Peak, NNSC (Nigerian National Supply Company), Carnation, condensed Peak and Coast milk. All these samples were analysed immediately after purchase.

Oils, condiment and soups

The oils analysed were palm oil, melon oil, groundnut oil, golden oil, turkey oil and brands of corn oil. The locally processed oils were purchased the same day they were prepared and were analysed 24 or 48 h after purchase.

Condiment
Freshly prepared 'Iru'—a popular Nigerian soup condiment prepared by the fermentation of the cotyledons of African locust bean (*Parkia filicoidea* Welw) was purchased from three different markets.

Soups
The following groups, prepared by different ethnic groups in Nigeria, were also investigated.

A typical Bendel soup. Name: bitter leaf (Ogbono soup). Ingredients: beef, smoked fish, crayfish, bitter leaf (a typical vegetable) and Okro.

A typical Igbo soup. Name: Ugu (Ogbono) soup. Ingredients: beef, dried fish, stockfish, crayfish, vegetables (Ugu) and Okro.

A typical Hausa soup. Name: Kuka soup (Baobab). Ingredients: beef, parkia cotyledons, powdered baobab leaves.

A typical Yoruba soup. Name: Melon (Egusi) soup. Ingredients: ground melon, boiled fish.

Generally, all the soups had fresh palm oil, common salt (NaCl), tomato, onions and pepper.

Margarine

A variety of hydrogenated fats were also investigated.

Others

These included two brands of Heinz baked beans.

Malonaldehyde determination

The malonaldehyde content of the samples, except the milk and oil samples, was determined according to the detailed procedures of Shamberger *et al.*, (1977). However, the concentration of malonaldehyde in the milk and oil samples was determined by the method of Patton & Kurtz (1951).

RESULTS AND DISCUSSION

Malonaldehyde concentrations in imported canned fish products and the fish harvested and processed locally are presented in Table 1. The imported canned fish products contained various amounts of malonaldehyde ranging from 0·37 in Geisha (fish only) to 3·32 mg/kg in the Isabel brand. The Sarzan brand did not contain any detectable amount of malonaldehyde. The wide variation in the malonaldehyde contents of these fish products may be due to the level and efficacy of the antioxidants used, the type of other additives used, the nature of the fat content of the fish used, the duration of storage of the fish before processing, the nature of the oil in which the fish was packed and the effects of storage on the products. Alerta, a sardine brand stored in vegetable oil, had the highest malonaldehyde concentration. The Geisha (mackerel in tomato sauce) was found to have a higher value than the fish alone when warmed. Green & Price (1975) showed that the malonaldehyde level can be markedly

TABLE 1
Malonaldehyde Concentrations in Imported and Local Fish and Fish Products

Fish brand/sample	*Malonaldehyde concentration (mg/kg)*	
	Range	*Mean*
Sardines		
Hot Titus	0·62–2·52	1·38 ± 0·37
Rex	0·56–1·70	1·01 ± 0·22
Titus	0·94–2·83	1·92 ± 0·28
Isabel	1·43–3·32	2·14 ± 0·34
Witico	0·75–1·40	1·06 ± 0·12
Alerta	0·63–3·26	1·74 ± 0·28
Geisha (fish only)	0·37–0·61	0·45 ± 0·05
Geisha in soup (warmed)	0·45–0·63	0·54 ± 0·13
Sarzan	0·00	0·00
Mackerel (Scomber scombus)		
Raw	5·34–6·10	5·72 ± 0·27
Boiled	3·30–3·98	3·64 ± 0·24
Fried	3·14–3·86	3·41 ± 0·18
Smoked	0·53–0·61	0·56 ± 0·02
Clarias *species*		
Raw	0·26–0·29	0·28 ± 0·01
Boiled	0·35–0·47	0·40 ± 0·03
Traditionally smoked	1·30–1·47	1·39 ± 0·09
Solar dried	1·76–1·80	1·78 ± 0·02
Chrysichthys *species*		
Raw	0·84–1·03	0·94 ± 0·06
Boiled	0·89–1·03	0·96 ± 0·07
Fried	1·58–1·59	1·59 ± 0·01
Traditionally smoked	0·79–0·87	0·84 ± 0·02
Sarotherodon niloticus		
Traditionally smoked	1·36–1·50	1·45 ± 0·05
Solar dried	2·03–2·05	2·04 ± 0·04

reduced in meat by the addition of antioxidants and $NaNO_2$ and also by anaerobic storage.

Raw, boiled or fried mackerel (*Scomber scombus*) and traditionally smoked or solar-dried *Sarotherodon galilaeus* had higher malonaldehyde levels than other local fish and imported fish products. Much less malonaldehyde was found in the differently processed forms of the

Clarias and *Chrysichthys* species, *Sarotherodon niloticus* and *Hemichrome fasciatu.* The widely different levels of malonaldehyde in the locally harvested fish may be related to the degree of unsaturation of the fat of the different fish. It is expected that more malonaldehyde would be formed in fish with more saturated fat. While boiling, frying or smoking reduced malonaldehyde level in mackerel (*Scomber scombus*), similar treatments increased the concentration of malonaldehyde in *Clarias* and *Chrysichthys* species. Higher malonaldehyde levels in solar-dried adult *Sarotherodon galilaeus* than in juvenile *S. galilaeus* tend to suggest the influence of the age of a fish on its malonaldehyde content. However, the influence of the levels of malonaldehyde on the nutritive value of the fish needs to be investigated.

The malonaldehyde concentrations of the meat and meat products analysed are presented in Table 2. The malonaldehyde level of the imported meat products was lower than 1·00 mg/kg in all the imported brands studied. While boiling and frying increased the malonaldehyde levels in two brands of imported meat products—Morey and Unipyrenes—similar treatment decreased the concentration of the oncogenic substance in the Torero brand. There was no detectable amount of malonaldehyde in the Kondor brand. Information on the date of manufacture and importation of these meat products did not shed any light on the effect of duration of storage on the malonaldehyde levels of the meat products. However, the difference could be explained by differences in processing techniques and the type or nature of antioxidants employed in the manufacture of the meat products. The locally grilled beef (Suya) had the widest range of malonaldehyde concentrations of the meat and meat products investigated. Boiling and frying of beef had no appreciable effect on the malonaldehyde concentration. This was in contrast to the large increase in malonaldehyde observed by Shamberger *et al.*, (1977) when some beef samples were boiled or cooked. The high values recorded in the liver and beef extracts compared with other tissues tends to confirm the solubility of malonaldehyde in water. This is significant in that it shows the ease with which this oncogenic substance could be released from foodstuffs and, equally, in the organism. The locally grilled beef (Suya) and the smoked bush meat had higher malonaldehyde concentrations than as-purchased beef. While the latter has a low malonaldehyde concentration, it has been shown that it can contain oncogenes in the process of roasting and grilling (IARC, 1977). The analysed Suya was obtained from three locations in

TABLE 2
Malonaldehyde Concentrations in Imported and Local Meat and Meat Products

Sample	*Malonaldehyde concentration (mg/kg)*	
	Range	*Mean*[a]
Corned beef		
Morey (as purchased)	0·28–0·74	0·47 ± 0·12
Fried	0·80–0·84	0·82 ± 0·02
Boiled	0·56–0·67	0·62 ± 0·05
Unipyrenes		
As-purchased	0·37–0·46	0·43 ± 0·03
Fried	0·48–0·50	0·49 ± 0·01
Boiled	0·40–0·42	0·41 ± 0·01
Torero		
As-purchased	0·65–0·66	0·66 ± 0·07
Fried	0·23–0·30	0·27 ± 0·02
Boiled	0·27–0·29	0·28 ± 0·01
Beef samples		
Fresh	0·35–0·56	0·42 ± 0·05
Frozen (4 days)	0·32–0·72	0·48 ± 0·10
Fried	0·31–0·56	0·43 ± 0·06
Boiled	0·34–0·59	0·44 ± 0·05
Beef extract	0·82–1·36	1·09 ± 0·13
Locally grilled (Suya)	0·94–6·20	3·55 ± 1·24
Smoked 'bush meat' (grasscutter)	1·12–1·52	1·30 ± 0·08
Liver samples (from cow)		
Raw	0·24–0·37	0·30 ± 0·03
Cooked	0·52–0·68	0·57 ± 0·04
Fried	0·70–1·10	0·88 ± 0·06
Liver extract	0·56–0·84	0·70 ± 0·05
Fish brand/sample		
Sarotherodon galilaeus (Juvenile)		
Traditionally smoked	4·54–4·68	4·61 ± 0·07
Solar dried	4·45–4·59	4·52 ± 0·07
Sarotherodon galilaeus (Adult)		
Traditionally smoked	4·40–4·50	4·45 ± 0·04
Solar dried	5·60–6·60	6·10 ± 0·35
Hemichromis fasciatus		
Traditionally smoked	1·64–1·73	1·69 ± 0·04
Solar dried	2·06–2·20	2·13 ± 0·07

[a] Mean of eight samples ± standard error.

the Ilorin community. The grilling technique, coupled with the fact that in most cases the grilled meat waits, at times, 3 days without adequate storage facilities before sellers can dispose of it, may account in part for the wide range of malonaldehyde concentrations observed in this material. Since samples were purchased from three different areas, there is the possibility that a mixture of fresh and stale Suya was purchased.

Of all the vegetable oils analysed, the highest malonaldehyde concentrations were found in golden oil (Table 3) while the lowest value was observed in corn oil. Blue Band margarine had the highest malonaldehyde concentration of the hydrogenated fats.

Table 4 shows the malonaldehyde levels in four typical Nigerian soups. The Yoruba and Igbo soups had the highest and lowest malonaldehyde concentrations, respectively. The magnitude of the malonaldehyde level in the four typical Nigerian soups was positively correlated with the palm oil level in the soup. Hence, the Yoruba soup, known for its excess of palm oil, was found to contain more malonaldehyde than other soups.

Although milk and milk products were analysed for malonaldehyde, none of these materials contained any detectable amount. This was in agreement with the observation of Shamberger *et al.*, (1977).

TABLE 3
Malonaldehyde Level in Imported and Local Vegetable Oils and Hydrogenated Fats

Sample	*Malonaldehyde level (mg/kg)*	
	Range	*Mean*[a]
Oil types		
Palm oil	1·86–3·51	2·74 ± 0·30
Melon oil	1·35–2·75	1·83 ± 0·27
Groundnut oil	3·80–5·00	4·30 ± 0·22
Golden oil	4·40–4·50	4·50 ± 0·04
Corn oil	0·72–0·87	0·80 ± 0·05
Turkey oil	1·02–1·03	1·13 ± 0·005
Vegetable oil	1·70–1·71	0·27 ± 0·07
Hydrogenated fats (Margarines)		
Donald Cooks	0·93–0·94	0·94 ± 0·005
Fast	1·64–1·83	1·73 ± 0·06
Blue Band	4·50–5·20	4·90 ± 0·40
Planta	2·76–2·81	2·79 ± 0·005

[a] Mean of eight samples ± standard error.

TABLE 4
Malonaldehyde Concentration in Soup Condiment and Typical Nigerian Soups

Sample	*Malonaldehyde concentration (mg/kg)*	
	Range	*Mean*[a]
Fermented locust-bean (Iru)[b]	0·89–1·82	1·24 ± 0·25
Soup		
Typical Hausa soup (Kuka)	0·50–1·00	0·75 ± 0·18
Typical Igbo soup (Ugu/Ogbono)	0·24–0·47	0·32 ± 0·06
Typical Yoruba soup (Egusi)	0·84–1·54	0·99 ± 0·17
Typical Bendel soup (Ogbono)	0·09–0·37	0·27 ± 0·07

[a] Mean of eight samples ± standard error.
[b] A popular soup condiment.

There is a paucity of information on the level of malonaldehyde that could be lethal to man and the possible cumulative effect(s) of long periods of ingestion of small quantities of dietary malonaldehyde. The fact that more than 47% of the food items screened contained more than 1·2 mg of malonaldehyde and, representing 10% of the malonaldehyde concentration that may pose a health hazard, calls for further appraisal of all food items for their malonaldehyde concentration.

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