

Full Length Research Paper

Effects of ethanolic extract of garlic, roselle and ginger on quality attributes of chicken patties

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Efficiency of ethanolic extracts of garlic, ginger and roselle on quality attributes of chicken patties was investigated. Sensorial qualities were evaluated using a 9-point hedonic scale. Lipid oxidation was assessed by monitoring malondialdehyde formation with 2-thiobarbituric acid (TBARS) assay. Total plate count (\log_{10} CFU/g) and Warmed Over Flavour (WOF) were determined on days 0, 7 and 14 of refrigerated storage while proximate composition was determined on freshly prepared patties using a standard procedure. Sensory evaluation revealed high scores for Overall Acceptability (OA) of patties containing the plant extracts while the highest score of aroma was recorded in products with ginger extract. The nutrient composition of the products were not affected ($P>0.05$) by the plant extracts. The cost of production reduced by 1.81, 0.49, 2.75 and 0.53% with the addition of 0.05% of garlic, ginger, roselle extracts and α -tocopherol respectively in comparison to the negative control. The WOF formation reduced from 17.65 to 39.29% by the inclusion of the extracts. The microbial load also reduced in comparison to the negative control. In conclusion, the plant extracts used in this study provided antioxidant and antimicrobial benefits to raw chicken patties during cold storage (4°C). As herbs/spices, they could be used to extend the shelf-life of chicken patties and provide the consumer with food containing natural additives, which might be more healthful.

Key words: Chicken patties, plant extracts, sensory attributes, lipid oxidation.

INTRODUCTION

Lipids oxidation is a major problem in Sub-Saharan Africa especially as the ambient temperature is very high and food preservation becomes a challenge. In other to maintain food product quality especially during cold storage, the application of suitable substance that has both antioxidant and antimicrobial activities may be useful to extend their shelf life and prevent economic loss (Yin and Cheng, 2003). This intervention becomes necessary because the products of lipid oxidation such as

malondiadehyde (MDA) have been implicated to cause pathological changes in the mucous membranes of the alimentary tract and to increase the cholesterol and peroxides in blood serum. Apart from all these serious implications on human health, lipid oxidation is responsible for reduction in food nutritional quality (Aguirrezabal et al., 2000), while microbial contamination can cause major public health hazards and economic loss in terms of food poisoning and meat spoilage.

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Table 1. Formulation of experimental chicken patties (% Weights).

Ingredient (%)	Treatment				
	P ₁	P ₂	P ₃	P ₄	P ₅
Breast Muscle	70.00	70.00	70.00	70.00	70.00
Fat	7.00	6.95	6.95	6.95	6.95
Binder	5.00	5.00	5.00	5.00	5.00
Water/ice	10.00	10.00	10.00	10.00	10.00
Sugar	1.00	1.00	1.00	1.00	1.00
Salt	2.00	2.00	2.00	2.00	2.00
^a Spices	3.50	3.50	3.50	3.50	3.50
Monosodium glutamate	1.50	1.50	1.50	1.50	1.50
Garlic extract	-	0.05	-	-	-
Ginger extract	-	-	0.05	-	-
Roselle extract	-	-	-	0.05	-
α-Tocopherol	-	-	-	-	0.05
Total	100.00	100.00	100.00	100.00	100.00

^aWhite pepper (30%), hot pepper (40%) and powdered nutmeg (30%). P₁, No additive (Negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α-tocopherol (positive control).

Fortunately, many researchers have indicated that lipid oxidation and microbial growth in meat products can be controlled or minimized by using either synthetic or natural food additives (Gray et al., 1996; Mielnik et al., 2008). However, the use of synthetic antioxidants, such as butylated hydroxyanisole (BHA) or butylated hydroxytoluene (BHT) have been related to humans health risks resulting in strict regulations over their use in foods (Hettiarachchy et al., 1996). On the other hand, natural substances possessing antioxidant and antimicrobial properties have the advantage of being readily accepted by consumers who are becoming more health conscious.

This concern has aroused a great interest in natural additives (Pokorny, 1991) and their utilization in meat and meat products is increasingly important because consumers are daily demanding additive-free or natural products. Research for new bio-efficient antioxidants has particularly focused on natural antioxidants to respect consumer's concern over safety and toxicity. Fortunately, the Sub Saharan Africa is endowed with many herbs and spices that can function as both antioxidant and antimicrobial. Garlic (*Allium sativum*), ginger (*Zingiber officinale*), and roselle (*Hibiscus sabdariffa*) are among some tropical plants commonly found in the study area and have been reported to have antioxidant and antimicrobial properties (Agarwal, 1996). The objective of this study was therefore, to investigate the effect of ethanolic extracts of garlic, ginger and roselle on cost of production, sensory, physical, and keeping qualities of chicken patties.

MATERIALS AND METHODS

Dried ginger, garlic and roselle were obtained from the Crop Research

Institute of Nigeria, Ibadan. Meat curing salt and pork fat (lard) were obtained from the Meat Processing Unit of the Department of Animal Science, University of Ibadan, Nigeria. Food grade sodium tripolyphosphate was obtained from Germany (GmbH andCo.KG, Adalbert-Raps-str.1–D95326). All other additives were purchased from the Bodija Central Market in Ibadan, Nigeria.

Extraction of plant materials

The extraction was carried out according to the method described by Fatope et al. (1993). 20 g each of the powdered plant samples were percolated at room temperature (25°C) with 400 ml 97% ethanol for ginger, garlic and roselle, respectively in 400 ml beakers (thus achieving 1:20 ratio). These were prepared in multiples to ensure enough extractions for the study. The beakers were covered with foil paper, shaken and left to stand for two weeks with regular shaking. After two weeks, the suspensions were filtered and the filtrates were concentrated using Rotatory Evaporating Machine at 40°C. The extracts were labelled accordingly and stored in the refrigerator (4°C) until used.

Meat patties preparation/ experimental design

The experimental product formulation recipe is shown in Table 1. Pork fat and breast muscle meat from eight week old freshly slaughtered Arbor Acre broiler chicks, manually deboned were ground using a Super Wolf (MADOMEW 513, Maschinerbrik Domhan, GmbH, Germany) grinder through 4 and 3 mm sieve plates, respectively. Ground chicken breast muscle, lard and spices were chopped using a table top MTK 561 meat cutter (MA^(R) Grant, Germany). The chopping temperature was maintained at 15°C for 20 min to obtain a meat emulsion of desirable consistency. A total of 10 kg emulsion was prepared and used for the chicken patties preparation. 2 kg of the emulsion was assigned to each treatment while each treatment was replicated four times in a completely randomized design.

The antioxidant extracts were added to each of the emulsion portions as follows; treatment 1 (P₁), no additive (negative control); treatment 2 (P₂), 0.05% of garlic extract; treatment 3 (P₃), 0.05% of

ginger extract; treatment 4 (P₄), 0.05% roselle extract; treatment 5 (P₅), 0.05% vitamin E (positive control) (Table 1). The extracts were thoroughly mixed with the respective emulsion. Thereafter, 100 g of the thoroughly mixed emulsion was shaped using a patty cutter and cooked in an electric oven at 180°C to an internal temperature of 72°C. The oven was preheated for 10 min to ensure uniform temperature was achieved inside before the actual cooking process commenced.

The core temperature of each patty was measured using a meat piercing thermometer (Troy, USA). All cooked patties were conditioned at room temperature (27°C) after which they were chilled at 2°C overnight. The chilled patties were weighed and vacuum packed separately and store at -4°C for further analysis. The chilled samples were coded P₁, P₂, P₃, P₄ and P₅ for treatments 1, 2, 3, 4 and 5, respectively (Table 1).

Proximate composition, pH and physical properties of chicken patties

The proximate composition of chicken patties was determined using procedures described by AOAC (1990) for moisture, protein, fat and ash determinations. The analyses were made in triplicates for all the treatments. A pH meter fitted with glass electrode (FC200, H19024C, Hanna Instruments, Singapore) was used to measure the pH of the cooked patties after cooling to room temperature (27°C). The weight of samples in each treatment was taken before cooking and after to determine the cooking loss.

Water Holding Capacity (WHC) was determined following the method of Suzuki et al. (1991). In the process, cooked patties (10 x 10 x 5 mm) from each treatment were weighed individually onto two filter papers and pressed between two plexi glasses for a minute using a vice. The samples were then oven dried at 65°C for 48 h to determine the moisture content. The amount of water released from the samples was measure indirectly by measuring the area of the filter paper wetted relative to the area of pressed sample.

The WHC was calculated as follows:

$$\text{WHC} = \frac{100 - [(Ar - Am) \times 9.47]}{Wm \times Mo} \times 100$$

Where, Ar = Area of water released form meat (cm²); Am = Area of meat sample (cm²); Wm = Weight of meat in mg; Mo = Moisture content of meat (%); 9.47 is a constant factor.

Yield of the product was calculated using the following formula:

$$\text{Yield} = \frac{\text{Weight of product}}{\text{Initial weight of sample}} \times 100$$

Lipid oxidation

The 2-thiobarbituric acid (TBARS) assay was carried out according to the procedure of Schmedes and Holmer (1989). Patty sample (10 g) was mixed with 25 ml of trichloroacetic acid solution (200 g/l of TCA in 135 ml/l phosphoric acid solution) and homogenized in a blender for 30 s. After filtration, 2 ml of the filtrate were added to 2 ml TBA solution (3 g/l) in a test tube. The test tubes were incubated at room temperature in the dark for 20 h; then the absorbance was measured at 532 nm by using UV-VIS spectrophotometer (model UV-1200, Shimadzu, Japan). TBA value was expressed as mg malonaldehyde per kg of patty. The analyses were made in duplicates for all the treatments.

Microbial load evaluation

Patty sample (10 g) was homogenized with 90 ml of sterile peptone water (1 g/l) in a laboratory homogenizer (AM-5 Ace homogenizer, Nihonseiki, Japan) and serial dilutions were prepared, then 0.1 ml of each dilution was spread with a bent sterile glass rod on duplicate plates of pre-poured and dried standard plate count agar (Nissui Pharmaceutical, Japan). After 48-h incubation at 25°C, colonies were counted and results were expressed as log₁₀ CFU/g of patty sample.

Sensory attributes and Warmed Over Flavour (WOF) evaluation

Twenty-five (25) consumer panellists made up of staff and students of the University of Ibadan evaluated the flavour, juiciness, tenderness, appearance, taste and overall acceptability of the product using a 9-point Hedonic scale (9 = like extremely, 5 = neither like nor dislike and 1 = dislike extremely). The chicken patties were sliced to approximately equal bite size of 2 cm², wrapped in kitchen foil and warmed in an oven at 180°C for 5 min before serving. Similar methodology was applied to samples for WOF determination except that WOF was determined at days 1, 7 and 14 after storage at -4°C. All products were blind coded with 3-digital random numbers and the orders of serving samples were randomised. Water was offered to rinse the mouth in-between tasting. Panellists sat in such a manner that ensured independence throughout the entire duration of product evaluation. The evaluation room was well illuminated with white fluorescent lights (Poste et al., 1991) and there were nothing such as noise and unpleasant odours to detract the attention of the panellists.

Statistical analysis

The data generated from the study were subjected to one-way analysis of variance (ANOVA) and significant differences (P<0.05) between means were determined by Scheffe multiple comparison test using SPSS (2006) 16.0.1 for Windows.

RESULTS AND DISCUSSION

The percentage compositions for moisture, protein, fat and ash of chicken patties are reported in Table 2. These parameters were not affected by the inclusion of the plant extracts as there were no significant differences between their means and those of the two controls. The protein values were 28.12, 28.41, 28.01, 28.78 and 28.92% for P₁, P₂, P₃, P₄ and P₅ samples, respectively. The pH values were not affected significantly (P>0.05) with the use of the plant extracts. Addition of the different extracts did not cause any significant change in the nutritional content of the products. The finding was in agreement with the report of Sallam et al. (2004) that the addition of different garlic forms did not cause any significant change in pH value, protein, ash and fat contents of chicken sausage.

The pH values of patties from both the negative and positive control were 5.91 respectively, while the treated patties (P₂, P₃ and P₄) had similar pH values of 5.92 each. Although, there were no significant differences in the pH values obtained in all the products however, it is worthy

Table 2. Proximate composition (%) and pH of cooked chicken patties with or without plant extracts.

Parameter	Treatment					SEM
	P ₁	P ₂	P ₃	P ₄	P ₅	
Moisture	32.50	34.50	33.47	33.00	32.52	1.21
Protein	28.12	28.41	28.01	28.78	28.92	1.16
Fat	14.42	14.19	14.16	14.58	14.49	0.66
Ash	2.76	2.93	2.95	3.01	2.68	0.76
pH	5.91	5.92	5.92	5.92	5.91	0.01

Means in same row with similar superscripts are not significantly different ($P>0.05$). P₁, no additive (negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α -tocopherol (positive control); SEM, standard error of the means.

Table 3. Yield and water holding capacity (WHC) of chicken patties as influenced by ethanolic extracts of ginger, garlic and roselle.

Parameter	Treatment					SEM
	P ₁	P ₂	P ₃	P ₄	P ₅	
Yield (%)	84.39	86.02	84.88	86.85	85.45	1.54
WHC (%)	50.96 ^a	44.36 ^b	46.25 ^b	47.19 ^b	52.20 ^a	2.55
Production cost (#/kg)	700.32	687.63	696.87	681.06	696.61	-

Means in same row with similar superscripts are not significantly different ($P>0.05$). P₁, no additive (negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α -tocopherol (positive control); SEM, standard error of the means.

of note that at the acidic pH the condition becomes hostile for microbial growth. The range of pH values obtained in this study is lower than the pH range of 6.65 (in control samples) to 6.78 (in fresh garlic-formulated sausage) obtained by Sallam et al. (2004). The difference in the pH values could be due to the differences in product and product formulations as pointed out by Akwetey et al. (2014).

The cost (#/kg) of producing chicken patties with ethanolic extracts of garlic, ginger and roselle inclusion varies from N700.32 (negative Control, P₁) to N681.06/kg in patties containing 0.05% roselle extract (Table 3). These resulted in 1.81, 0.49, 2.75 and 0.53% reduction in production cost respectively for using 0.05% of garlic extract, ginger extract, roselle extract and α -tocopherol. Chicken patty processors who would adopt and utilize roselle extract stand to benefit more by way of higher savings (2.75 %) on production cost. While, the use of garlic and ginger extract resulted in 1.81 and 0.49% reduction in cost of production respectively. This reduction in cost of production is an added advantage since these extracts were used essentially as antioxidant and antimicrobial. Such savings on the cost of production could lead to reduction in the price /kg of the product and also encourage increased consumption which might lead to increment in the volumes of the product sold.

Water holding capacity (WHC) varies significantly

($P<0.05$) in chicken patties containing the plant extracts as compared to the two controls. At high WHC the product yield was expected to increase correspondently however, the product yield obtained in this study contradicted that assertion.

The product yield was 84.39% for the negative control (P₁) and 86.02, 84.88 and 86.85% for patties containing garlic, ginger and roselle extracts respectively while the patties with α -tocopherol gave product yield of 85.45%.

Results of the warmed-over flavour of chicken patties as assessed by the consumer panellists are reported in Table 4. There were significant differences in the values obtained in each of the storage days with the negative control (P₁) having the highest values in each storage day. The use garlic extract resulted in 34.62% reduction in warmed-over flavour after 24 h storage at 4°C while the use of ginger and roselle led to 26.92 and 23.08% reduction, respectively. The result obtained on the 7th day of storage showed no significant difference ($P>0.05$) in the values obtained for samples treated with garlic extract and α -tocopherol while those of ginger and roselle were also similar ($P>0.05$). The efficacy of garlic and roselle extract seemed to have reached its peak on day seven of storage as there were noticeable reduction in the rate at which warmed-over flavour was reduced beyond day seven whereas; in the case of ginger extract, there was an improvement from 25.00 to 29.41%. For a short term

Table 4. Warmed over flavour (WOF) of chicken patties with or without plant extract.

Days of storage	Treatment					SEM
	P ₁	P ₂	P ₃	P ₄	P ₅	
1(%)	2.60 ^a NA	1.70 ^c (34.62)	1.90 ^b (26.92)	2.00 ^b (23.08)	1.50 ^d (42.31)	0.01
7(%)	2.80 ^a NA	1.70 ^c (39.29)	2.10 ^b (25.00)	2.10 ^b (25.00)	1.70 ^c (39.29)	0.02
14(%)	3.40 ^a NA	2.80 ^b (17.65)	2.40 ^c (29.41)	2.50 ^c (26.47)	2.20 ^d (35.29)	0.01

Means in same row with similar superscripts are significantly different ($P > 0.05$). Numbers in parenthesis indicate percent change (reduction) relative to negative control (P₁). NA, Not applicable; P₁, no additive (negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α -tocopherol (positive control).

Table 5. Lipid oxidation / thiobarbituric acid values (mg/Kg) of chicken patties with or without plant extract.

Days of storage	Treatment					SEM
	P ₁	P ₂	P ₃	P ₄	P ₅	
1(%)	0.78 ^a NA	0.68 ^b (12.82)	0.56 ^c (28.21)	0.72 ^b (7.69)	0.56 ^c (28.21)	0.01
7(%)	1.05 ^a NA	0.95 ^c (9.52)	0.93 ^c (11.43)	0.98 ^b (6.67)	1.01 ^b (3.81)	0.02
14(%)	1.90 ^a NA	1.52 ^b (20.00)	1.10 ^d (42.11)	1.22 ^c (35.79)	1.07 ^d (43.68)	0.01

Means in same row with similar superscripts are significantly different ($P > 0.05$). Numbers in parenthesis indicate percent change (reduction) relative to negative control (P₁). NA, Not applicable; P₁, no additive (negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α -tocopherol (positive control).

intervention (1-7 days storage) in chicken patties, any of the studied extract could be used while, for storage beyond 7 days the use of ginger extract is preferred.

Each of the ethanolic plant extract (Table 5) lowered the thiobarbituric acid level of their respective patties in comparison with the negative control (P₁). Ginger extract consistently gave the highest reduction in oxidation with values of 28.21, 11.43 and 42.11% for days 1, 7 and 14 of storage respectively as against values of 12.82, 9.52 and 20.00 for roselle and 7.69, 6.67 and 35.79 % for garlic treated samples for similar storage days. The percent reduction in oxidative value obtained for ginger were comparable to those of α -tocopherol with the exception of day 7 where the ginger extract had a higher value (11.43%) than that of α -tocopherol (3.81%).

In an earlier study, Formanek et al. (2009); Ibrahim et al. (2011) and Abu-almaaly (2011) reported that ginger extract as antioxidant was effective against TBA formation when incorporated into meat during frozen storage. Moreover, polyphenolic extracts are excellent electron and proton donors, and their intermediate radicals are quite stable due to electronic delocalization phenomena as well as the lack of position attackable by oxygen (Djenane et al., 2005). As the day of storage lengthened especially from 7 to 14 days, the oxidative effect of the extracts became more pronounced. Sallam et al. (2004) determined the antioxidant activity of garlic in chicken sausages and reported a reduction in values in garlic treated samples compared with the control. In a similar way, the efficacy of garlic as antioxidant was reported by Park et al. (2008), in their study with garlic

and onion in fresh pork belly and loin during refrigerated storage. Garlic also has high total phenolic content showing high antioxidant activity. These properties make garlic good free radical scavengers (Kikuzaki and Nakatani, 1993; Schulick, 1993; Thippeswamy and Naidu, 2005). The calyx of the roselle plant on its own part has long been recognized as a source of antioxidants (Mohd-Esa et al., 2010).

Roselle calyces were reported to contain higher antioxidant properties compared to BHA and vitamin E most probably due to its high polyphenol components (Rhee et al., 2001). In the current study, since the natural extracts used in preparing chicken patties contained phenolic compounds, these substances could cause an inhibition of the chain reactions during lipid oxidation (El-Diwani et al., 2009).

Antimicrobials agents are used in food for two main reasons: to control natural spoilage processes (Naidu, 2000) and to prevent/control growth of micro-organisms for food safety. This study demonstrated that the use of ethanolic extract of garlic, ginger and roselle reduced the microbial load of the patties across the treatments in each of the storage period compared to the control (Table 6). Ginger extract conferred the highest antimicrobial activity on the product in each of the storage day since products containing ginger consistently has the least microbial load in each of the days. Apart from its noticeable antioxidant activity ginger has been reported to be effective as antimicrobial (Shamsuddeen et al., 2009; Ibrahim et al., 2011). Ginger has been shown to be effective against the growth of both Gram-negative and

Table 6. Microbial load of chicken patties as influenced by ethanolic extract of ginger, garlic and roselle ($\times 10^2$ CFU/gm).

Days of storage	Treatment					SEM
	P ₁	P ₂	P ₃	P ₄	P ₅	
0	3.46 ^a	3.29 ^a	2.95 ^b	3.32 ^a	3.38 ^a	0.11
7	4.51 ^a	3.94 ^b	3.02 ^c	4.13 ^b	4.27 ^a	0.08
14	4.98 ^a	4.12 ^b	4.07 ^c	4.86 ^b	4.93 ^a	0.17

Means in same row with similar superscripts are significantly different ($P > 0.05$). P₁, No additive (Negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α -tocopherol (positive control).

Table 7. Sensory attributes of cooked chicken patties as influenced by antioxidant extracts.

Parameter	Treatment					SEM
	P ₁	P ₂	P ₃	P ₄	P ₅	
Aroma	3.60 ^c	4.20 ^b	4.70 ^a	4.20 ^b	4.40 ^b	0.01
Tenderness	5.30 ^c	5.60 ^a	5.70 ^a	5.50 ^b	5.60 ^a	0.02
Juiciness	5.60	5.80	5.70	5.60	5.70	0.01
Colour	6.20	6.30	6.40	6.50	6.20	0.13
O. Acceptability	6.00 ^d	6.50 ^b	6.20 ^c	6.60 ^b	7.10 ^a	0.06

Means along the same row with the same superscripts are not significantly different ($P < 0.05$). 9, Like extremely; 5, neither like or dislike; 1, dislike extremely; P₁, no additive (negative control); P₂, 0.05% of garlic extract; P₃, 0.05% of ginger extract; P₄, 0.05% roselle extract; P₅, 0.05% α -tocopherol (positive control).

positive bacteria including *Escherichia coli*, *Proteus vulgaris*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Streptococcus viridans* (Thompson et al., 1973). Sulphur and polyphenols present in garlic is responsible for its antibacterial, antifungal and antioxidant activity (Benkeblia, 2004).

The sensory evaluation of food products to any food processing technology is very important in determining the consumer acceptability (Mohamed et al., 2011). Results of the sensory attributes of chicken patties as assessed by the consumer panellists are reported in Table 7.

There were no significant differences ($P > 0.05$) in juiciness and colour score in both control (negative and positive) and the ethanolic extract treated products. The extracts significantly increased the aroma and tenderness score (Table 7) in comparison with the negative control products (P₁). However, the patties containing ginger extract has the highest score for aroma while there was no significant difference in score for products containing garlic, roselle and α -tocopherol.

Garlic and ginger extracts gave comparable result to that of α -tocopherol in terms of tenderness while that of roselle treated samples was lower. The order of the overall acceptability of the chicken patties was $P_5 > P_4 > P_2 > P_3 > P_1$.

Conclusion

This study concluded that the ethanolic extract of garlic,

ginger and roselle provided antioxidant and antimicrobial benefits to raw chicken patties during cold storage (4°C). However, ginger seemed to have longer antioxidant potency than garlic and roselle. The result shows that the ethanolic extracts had salutary effects on the sensory profile of chicken patties especially by reducing the development of Warmed-Over Flavour (WOF). Therefore, it is suggested that ginger, garlic or roselle extract as a natural herb, could be used to extend the shelf-life of chicken patties and provide the consumer with food containing natural additives, which might be more healthful.

Conflict of interests

The authors have not declared any conflict of interests.

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