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Evaluation of the Functional Food Potential of Bamirad (a Ginger-Spiced) Cheese Produced in the Western Highlands of Cameroon

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Abstract. In this study, cheese was modified to enhance its functional characteristics thereby encouraging its consumption. Consequently, a ginger-spiced cheese (Bamirad) was produced and the effects of feed supplementation with cheese on blood lipid profile were evaluated using 36 male Wistar rats in four groups. Total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol and triacylglycerols were determined. There were significant ($P<0.05$) changes indicating: weekly increases of triacylglycerols for all treatments, higher total cholesterol for the 0.0 % ginger treatment, and a decline of low-density lipoprotein for 1.0 % ginger treatment. The LDL/HDL ratio was very low, indicating that this cheese is a functional food, a potential exploitable for the well-being of the consumer.

Keywords: Bamirad cheese, functional food, lipid profile.

Introduction

Cheese is a food item obtained by the coagulation, draining and ageing of milk proteins. When consumed, like all other foods, provides energy, nutrients for growth and replacement or regulatory substances for proper physiological processes of the body. However, there is the growing phenomenon of functional foods attributed to food substances endowed with other benefits beyond basic nutritional requirements. Practically, a food substance is regarded as functional if it can beneficially affect the body beyond adequate nutrition, in a way which is relevant to either the state of well-being and health or the reduction of the risk of developing a disease (Roberfroid, 2000).

The functional foods phenomenon within the past decade, created a worldwide impact in the food industry, where activities were geared towards finding solutions to consumers' worries and preoccupations about their health and well-being. Indeed, cancers, diabetes, cardiovascular, inflammatory and other chronic diseases have been particularly deadly, being responsible for 60% of the causes of human deaths worldwide with cardiovascular diseases (CVDs) most prominent. In developing countries (Sub-Saharan Africa, North-East Asia, Latin America), the prevalence of CVDs is more than 20% being almost the same as that of infectious and nutritional diseases formerly classified as the most common in these regions (WHO, 2003).

Spices are essentially plant substances, which in addition to imparting desirable flavours to food, are endowed with therapeutic potentials. Essential oils, phenols and flavanoids involved in reducing the risk of vascular disease and heart attacks (Abdou-Bouba *et al*., 2010; Li *et al*., 2007). Furthermore, compounds that exhibited antimicrobial, anti-inflammatory, antioxidant and lipid lowering effects have also been identified in some spices including: ginger, onions, garlic and parsley (Milner, 2000).

Dairy products, though very good protein sources have been implicated in high blood cholesterol levels. Although cheese by its nature of being a fermented milk product is a functional food, the incorporation of spices (Kim *et al*., 2006; Karvonen *et al*., 2002; During, *et al.,* 2000) could re-enforce its functional food capacity. The Bamirad cheese, in which ginger was added during manufacture, was evaluated for its functional food potential. The study was carried out

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focussing mainly on the evaluation of the effects of Bamirad cheese on blood lipid profile of male rats in which the cheese was a supplement in the rats' feed.

Materials and Methods

Meterials. The cheese was made following the procedure described earlier (Mendi *et al.,* 2009). In the study, two levels (1.0 and 1.5 % ginger powder) of spiced-cheese were tested. The cheese was made in the food technology laboratory of the Institute of Agricultural Research for Development (IRAD) Bambui in the north-west region and transported in ice-packed flask to the veterinary research laboratory of IRAD Wakwa-Ngaoundere in the Adamaoua region and stored in a refrigerator till used.

Animal feed. Adult male Wistar rats were obtained from the animal house of the faculty of science of the university of Yaoundé I, Cameroon and transported in plastic cages to IRAD Wakwa-Ngaoundere.

Methods. After a wash out period of one week, 36 rats were randomly distributed into four groups (average weights ranged from 229.3 to 244.4 g) for a complete randomised block (animals' weights) design study. The ingredients used to compound the rats' chow were: wheat bran, corn meal, soya bean meal, fish meal and common salt.

The groups were randomly assigned to feed supplementation regimes as follows: animals of group A consumed plain cheese (0.0% ginger), those of group B received cheese spiced at1.0% ginger, and the group C animals ate cheese spiced at 1.5% ginger, while the group D animals did not receive cheese as supplement.

The 9 rats in each group were distributed into three polypropylene base standard rats' cages (3 rats/cage) and were housed in a well ventilated, natural day light/night darkness cycle, laboratory room, with water and the basic feed ad libitum. Cheese (30 g/cage) was served first every morning before the basic feed. Baseline data were collected prior to start of cheese supplementation.

Lipid profile. Weekly blood samples were collected after an overnight fasting, by caudal vein puncture in 1.5 mL Eppendorf tubes (Fisher Bioblock Scientific 2002- France) that contained ethylene diamine tetra-acetic acid (EDTA) as anti-coagulant. The blood was centrifuged (SIGMA 3K 20 Germany) at 5000 rpm (revolutions per minutes) for 15 min and then the plasma was obtained and used for the determination of triacylglycerols, total cholesterol, low-density lipoprotein (LDL) cholesterol.

On the last day of feeding, the rats were sacrificed by chloroform anaesthesia and blood was collected by cardiac puncture. There was enough plasma for the determination of high density lipoprotein cholesterol (HDL) in addition to the other lipid parameters that were being assayed.

Total cholesterol. The determination of total cholesterol was done by using cholesterol liquid kits, enzymatic colorimetric test. CHOD-PAP method for the "*in vitro*" determination of cholesterol in serum or plasma (QUIMICA CLINICA APLICADA S.A., Spain). In this method, total cholesterol was determined by oxidation, with concomitant release of hydrogen peroxide which was assayed.

HDL cholesterol. The determination of high-density lipoprotein cholesterol (HDL) was done using the human cholesterol liquicolor test kit, with a precipitant and a standard following the semi-micro procedure (HUMAN Gesellschaft für Biochemica und Diagnostica mbH-Germany).

The principle was that the chylomicrons, very low density lipoproteins VLDL and low density lipoproteins LDL are precipitated by addition of phosphotungstic acid and magnesium chloride. After centrifugation the supernatant fluid contains the HDL fraction, which is then assayed for HDL-cholesterol with the human cholesterol liquicolor test kit.

The reagents comprised the precipitant for semi-micro assay that was diluted with 20 mL of distilled water for the contents of one bottle and the standard solution which was used as supplied. The procedure commenced with precipitation that was done by pipetting 0.2 mL of sample (serum) into centrifuge tubes, 0.5 mL of precipitant added, contents were well mixed and allowed to stand for 10 min at room temperature (18-23 °C) before centrifugation for 5 min. The clear supernatant was separated from the precipitate and used for the determination of the cholesterol concentration.

Data analysis. The changes in variables were calculated as follows:

$$\frac{\text{value determined at week } - \text{ initial value}}{\text{initial value}} \times 100 = \%\ \text{change}$$

Data were subjected to the analysis of variance (ANOVA) using SigmaPlot software version 11.0 with

Holm-Sidak method to compare means at the 95% significant level.

Results and Discussion

Lipid profile of rats. The plasma levels of triacylglycerols, total cholesterol and LDL cholesterol of rats before the study are presented in Table 1, where, there were significant ($P<0.05$) differences. The figures that follow illustrate the differences observed after the feeding period.

Table 1. Lipid profile of rats before start of cheese supplementation

Lipid profile (mmol/L)	Rat groups/feed regime (% ginger spice)			
	A (0.0)	B (1.0)	C (1.5)	D (no cheese)
Triacylglycerols	$0.84^{a}\pm0.08$	$0.55^{b}\pm0.20$	$0.84^{a}\pm0.08$	$0.69^{ab}\pm0.23$
Total cholesterol	$0.60^{b}\pm0.12$	$0.95^{a}\pm0.22$	$0.82^{ab}\pm0.20$	$0.85^{ab}\pm0.21$
LDL cholesterol	$0.48^{a}\pm0.15$	$0.55^{a}\pm0.15$	$0.53^{a}\pm0.10$	$0.61^{a}\pm0.21$

Averages ± standard deviations (n=9); values with different letter superscript along the same row denote a significant difference at $P<0.05$.

Triacylglycerols. There were significant ($P<0.05$) weekly exponential increases for all treatments (Fig. 1).

Total cholesterol. The weekly increase of total cholesterol was significantly ($P<0.05$) higher for the 0.0 % ginger-spiced cheese treatment only (Fig. 2).

LDL cholesterol. The weekly decline of LDL cholesterol was significant ($P<0.05$) for the 1.0% ginger-spiced cheese treatment only (Fig. 3).

The effects of the different diets fed to rats in four experimental groups, on their plasma lipids revealed an increase of triacylglycerols (TAG) and total cholesterol (TC), but a decrease of LDL cholesterol for all the treatments. The weekly increases of TAG were significant ($P<0.05$) for all treatments, while, the changes of TC and LDL were significantly ($P<0.05$) different for the 0.0 % ginger-spiced cheese treatment only.

Dairy products like cheese and butter are known for their ability to raise blood total cholesterol levels (Lokuruka, 2007). The role played by phytochemicals in blood lipid modification when consumed in diets was evident in these observations, accounting for the low values of the triacylglycerols and total cholesterol increases for the ginger-spiced cheese diet groups. Similarly, the reduction of plasma and hepatic cholesterol levels had been reported in mice when fed ground whole flaxseed diet as compared to the control diet of 0.1% cholesterol and 30% kcal fat. Also, soya bean protein

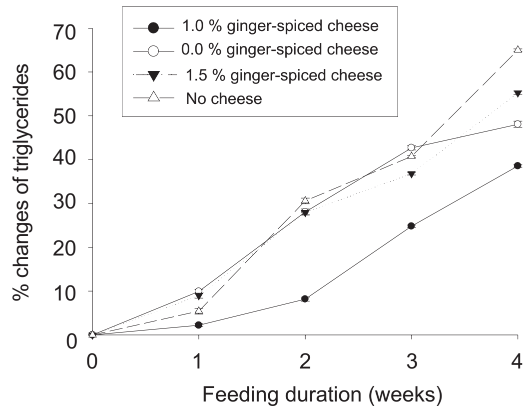

Fig.1. The effects of cheese supplementation on plasma triacylglycerols.

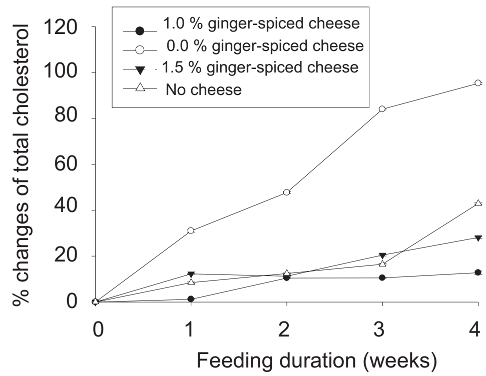

Fig. 2. Variation of total cholesterol of rats supplemented with cheese.

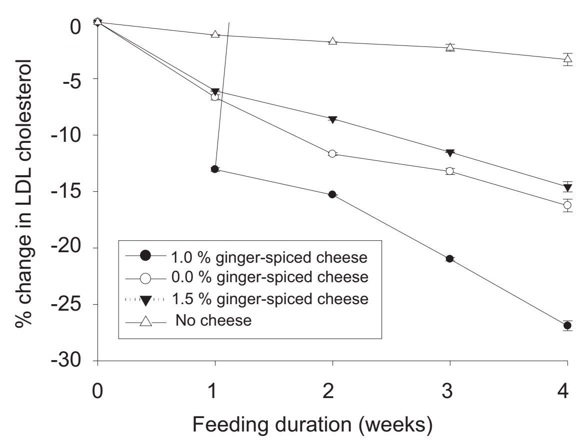

Fig.3. Variation of plasma LDL cholesterol of rats supplemented with cheese.

based diets have been observed to effectively lower plasma total cholesterol, triacylglycerols and LDL cholesterol compared to the control cholesterol-rich diet (Pellizzon *et al.*, 2007; Pittaway *et al.*, 2007; Sheridan *et al.,* 2007; Yang *et al.*, 2007). In some studies, for example, Al-Amin *et al.* (2006) observed that aqueous extracts of ginger had actually been used to treat diabetic rats, lowering their serum triacyl-glycerols and cholesterol levels by 41 and 44%, respectively.

The overall reduction in LDL cholesterol, usually termed the "bad" cholesterol further demonstrated the important role of phytochemicals (Al-Numair, 2009) in blood lipids since the control diet was also rich in soya bean and corn oil, all of which are favourable in cholesterol management. However, the 1.0% ginger-spiced cheese demonstrated additional functional advantage of this food product.

Though cheese and other dairy products are rich in saturated fats and are often associated with the raising of blood cholesterols levels, the type and nature of fat, other nutrients in the diet and effect on lipid types differ. The prominent dairy saturated fatty acids, palmitic, myristic and lauric are directed to the formation of triacylglycerols immediately after absorption from the diet, but only the myristic and lauric acids raise plasma total cholesterol. Long chain fatty acids are said to have an adverse effect on LDL cholesterol (Lukuruka, 2007) so the decrease of LDL observed in the study was due in part to the cheese itself, and then the ginger effect.

The effects of the different diets on HDL. When the animals were sacrificed on the last day of the experiment, it was possible to have a good quantity of plasma for the determination of the high-density lipoprotein (HDL) cholesterol. Table 2 shows all lipid profile characteristics including HDL cholesterol which was significantly ($P<0.05$) lower for the 1.5% ginger-spiced cheese treatment. HDL is the "good" cholesterol as opposed to LDL the "bad" type. The LDL/HDL ratio was only slightly lower for the 0.0% ginger-spiced cheese treatment compared to the group not supplemented. When this ratio is low, the risk of developing associated diseases is also low (Ohlsson, 2010).

Table 2. The effects of cheese consumption on blood HDL cholesterol and other lipids of rats

Lipid profile (mmol/L)	Treatments (% ginger powder) A(0.0)	B(1.0)	C(1.5)	No cheese
Triacylglycerols	$1.00^{bc}\pm0.08$	$0.79^{c}\pm0.17$	$1.27^{a}\pm0.2$	$1.13^{ab}\pm0.15$
Total cholesterol	$1.16^{b}\pm0.24$	$1.08^{a}\pm0.34$	$1.05^{a}\pm0.09$	$1.22^{a}\pm0.25$
LDL cholesterol	$0.40^{b}\pm0.06$	$0.41^{b}\pm0.09$	$0.45^{b}\pm0.15$	$0.59^{a}\pm0.09$
HDL	$0.21^{a}\pm0.14$	$0.16^{a}\pm0.09$	$0.09^{b}\pm0.04$	$0.15^{a}\pm0.10$
LDL/HDL ratio	1.2±0.8	1.1±1.2	2.8±0.4	2.0±1.9

Averages ± standard deviations (n=9);values with different letter superscript along the row denote a significant difference at $P<0.05$.

Generally, fermented food products especially those of dairy origin, improve on the LDL/HDL ratio (Ajayi and Ajayi, 2009 Krissansen, 2007) hence the low values as observed.

The changes in the lipid profile characteristics of rats could also be associated with the number of beneficial microorganisms in their gut. The presence of fermentation bacteria in the gut had been responsible for an increase in propionate, hydrolysis of glycine and taurin-conjugated bile acids, enhancement of the excretion of bile acids in faeces, all of which end up in the lowering of blood cholesterol (Ohlsson, 2010 Adesokan *et al.*, 2009; Oozeer *et al*., 2002). Similarly, Safalaoh (2006) found that some microorganisms when included in poultry feed actually contribute to body weight gain of the birds.

Conclusion

In the evaluation of the functional food potentials of Bamirad cheese, it could be concluded that: the consumption of cheese in normal diets increases levels of triacylglycerols and total cholesterol in the blood, but the increase by ginger-spiced cheese diet is not as great as that of the plain cheese; ginger-spiced cheese lowers LDL cholesterol and improves on the LDL/HDL ratio hence, Bamirad cheese positively influences lipid metabolism.

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