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Research Article

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Effect of Ginger Inclusion in Yoghurt Production and Its Acceptability

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Abstract

Raw milk contains higher microbial loads, which scared consumers from consuming it fresh except it undergoes processing. Ginger possesses anti-microbial properties (*gingerol*) which if included in yoghurt products could improve its microbial loads, nutritive aspect and organoleptic status. Twenty litres of White Fulani raw milk was used with 100g of fresh ginger (blended with 20mls of water to extract the juice). Milk was pasteurized at 62 - 65°C for 30 minutes and processed into yoghurt with extracted ginger juice inclusion at 0% - T_1, 5% -T_2, 10% -T_3 and 15% - T_4, divided into four treatments and five replicates (of 1liters of milk per replicate) were conducted in a completely randomized design. Results shows that yoghurt had the highest ($p<0.05$) significant values for chemical composition but lower values in pH (6.26) and microbial loads (2.10×10^4 cfu/ml) than chemical composition, pH (4.59) and microbial loads of milk (4.63×10^4 cfu/ml). As ginger inclusion increase, milk fat in yoghurt decreases ($p<0.05$). T_2 (0.86%) and T_3 (0.81%) had the highest ($p<0.05$) ash content than T_4 (0.74%). T_3 with 10% inclusion of ginger performed best in mineral composition than other treatments. T_3 was also rated higher with (4.40) for overall acceptability than T_1 (4.00), T_2 (4.20), T_4 (2.80).10% inclusion of ginger, in yoghurt product will reduce the fat content, microbial loads, increases nutritive values and overall acceptability.

Introduction

Milk is one of the earliest diets for human beings, and it is as ancient as mankind itself, as it is the substance created to feed the mammalian infant, and may be defined as the normal secretion of the mammary gland of mammals. Nature designed milk as food for the young but thousands of years ago, mankind discovered the possibilities of milk and milk products as food for adults too. Raw milk can be consumed directly in the form of liquid milk, or may be converted into milk products in order to improve its keeping quality and nutritive value. In Nigeria, milk production is almost entirely from Fulani pastoralists, who are accustomed to extensive system of production. However, the milk is of low yield with poor quality as a result of poor sanitary methods of milking and low dairy genetic potential of breed [1].

The Nigerian dairy industry represents an important component of the agribusiness sector of the economy with great economic, nutritional, and social implications. Dairy products provide the most important amino acid required for body building as well as tissues repairs in human beings. Animal protein equally supplies its own level of energy required for daily activities. It is also essential for the synthesis of certain hormones, enzymes and body products in both man and animals, but often has high percentage of fat content. Some health benefits were attributed to dairy foods which are probiotic in nature [2]. Some of such benefits include their anti-carcinogenic, hypo - cholesterolemic and antagonistic actions against enteric pathogens and other intestinal organisms.

However, consumers always demand for nutritionally enriched milk and dairy products such as yoghurt, with reduced amount of fat content. Yoghurt is a tasty fermented milk product which is very nutritious and easily digestible. The fermentation of milk to yoghurt is brought about by the symbiotic growth of two types of bacteria, *Lactobacillus bulgaricus* and *Streptococcus thermophiles*. These are starter culture added to milk during yoghurt manufacture. Yadav *et al.*, (2015) [3] explained that these two bacteria are used in a 1:1 ratio. *S. thermophiles* produces the acid whereas the aroma components are formed by *L. bulgaricus*. The bacteria produced lactic acid acts on the milk protein to give yoghurt its texture and its characteristic taste [3].

Yoghurt may also be regarded as a probiotic carrier whose nutritional benefits exceed that of milk [2]. Other health benefits of yoghurt include prevention of diarrhea, promotion of good gum health, facilitate the absorption of calcium and thus preventing osteoporosis [4], he also stated that dairy products quality include such characteristics as chemical composition, physical properties, microbiological and sensory properties and nutritive value among others. It is useful to evaluate the sensory qualities (colour, taste, aroma and texture) of a product since these could determine its acceptability by consumers).

Therefore, there is need to increase on the quality of milk product with better nutritional benefit ingredient that can positively affect human health and increase nutritional effect of milk products, by evaluating the effect of ginger inclusion in yoghurt production and its acceptability.

Materials and Methods

Study Location

The experiment was carried out at the Animal Science laboratory in the Department of Animal Science, College of Agriculture, Ejigbo campus of Osun State University, Osogbo.

Sample Collection

Twenty litres of milk sample was obtained from the White Fulani breed at a Fulani settlement in Isundunrin, a small village close to Ejigbo, Osun State where White Fulani cattle breads were raised. The pH value for the milk was 6.5 at 25°C Yoghurt containing starter cultures (*Lactobacillus bulgaricus* and *Streptococcus thermophillus*) was also obtained from Habib Industries Ltd., Ilorin branch to serve as starter culture for the yoghurt. Ginger (*zingiber officinale*) was obtained from the Oja Oba market, Ejigbo, Osun State.

Pasteurization

The milk sample was pasteurized in the laboratory at a temperature of 62 - 65°C for 30 minutes to reduce the microbial load (to provide a suitable environment for the starter cultures to grow) and to denature the whey proteins. This allows the proteins to form a more stable gel, which prevents the separation of water during storage.

Preparation of Yoghurt and Ginger Juice

The pasteurized milk after cooling to a temperature of 40°C was processed into yoghurt following a standard procedure, of [1]. 400mls teaspoons of the yoghurt containing the starter culture was added to the milk and carefully stirred to get an even mixture. The mixture was then distributed into already sterilized quart bottles, covered tightly and placed into an incubator overnight i.e. a period of 24 hours for proper fermentation to produced yoghurt.

About 60g of ginger was washed, peeled and blend with 20ml of water. The extracted ginger juice was then added to the yoghurt at different levels of inclusion levels; (T_1- 0ml, T_2 -5ml, T_3 -10ml, and T_4 -15ml per 100ml of the yoghurt sample).

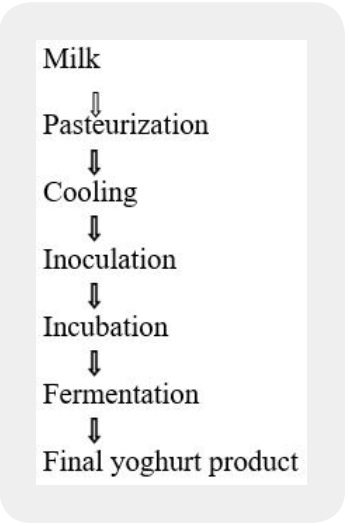

Figure 1: *Shows a flow chart of steps in yoghurt production*

Proximate and Mineral Composition

Samples (cow milk, yoghurt with different inclusion and ginger) were evaluated for proximate (moisture content, crude protein, fat, ash, total solids) and mineral composition. (Calcium, Potassium and Magnesium content) using AOAC (2005) [5].

Microbiological Analysis

The prepared yoghurt was analyzed for its microbial load according to Uzeh *et al.*, (2006) [6].

Palatability Status

A total number of forty trained panelists of ages ranging from 27-45 years were selected and randomly allocated to the samples. Equal quantity of the different samples (T_1- 0%, T_2 - 5%, T_3 - 10% & T_4 - 15%) allotted to each of the panelists was coded on a six point hedonic scale for color, texture, taste, aroma, hotness and overall acceptability.

Experimental Design/Statistical Analysis

The experimental design used for this study was completely randomized design (CRD). All the data obtained were subjected to one way analysis of variance (ANOVA). Means were compared using Turkey HSD test. The SPSS computer software was used for all statistical.

Results and Discussion

Discussion

Table 1 shows the proximate composition of milk used and yoghurt produced. Milk had the lowest significant values for ash content (0.72%), total solid (13.31%), acidity and crude protein (3.32%) than yoghurt produced with ash (0.82%), total solid (16.31%). The moisture content and the pH values was significantly ($p<0.05$) higher than values obtained for yoghurt produced. The nutritive values were higher in yoghurt produced and this was in agreement with the report of Adewumi *et al.*, (2014) [7] who explained that the increase protein content in yoghurt may be as a result of the starter cultures added, which facilitates the production of essential amino acids which are building blocks of proteins formation. The starter could affect all other nutrients positively. The decrease in pH values and the acidity implies that yoghurt products is more of acidic in mature, since it production enhances the production of lactic acid as explained by [3], when they worked on the importance of probiotic yoghurt for human health.

Table 1: *Proximate Composition of Milk Sample used and Yoghurt produced*

Parameters (%)	Milk	Yoghurt	SEM
Moisture	86.80^a	83.69^b	1.25
Crude protein	3.32^b	4.80^a	0.24

Fat	3.89[b]	3.88[a]	0.03
Ash	0.72[b]	0.82[a]	0.02
Total solids	13.37[b]	16.31[a]	0.05
Acidity	0.19[b]	1.03[a]	0.02
pH	6.26[a]	4.59[b]	0.25

[abcd]: Means with different superscripts along the rows are significantly different ($p<0.05$)

Tables 1, implies that production of yoghurt from milk increases protein, ash content and acidity nature of the products since yoghurt is a product after fermentation involving *streptococcus thermophillus* and *lactobacillus bulgaricus* bacteria but no effect on fat content.

Table 2 shows the minerals and microbial loads of raw milk and yoghurt produced. The ash / minerals content as shown on Table 1, was observed with higher valves for yoghurt and same were observed for the minerals composition. The calcium, potassium and magnesium increases in yoghurt production, while microbial loads decreases in the yoghurt produced than in the raw milk. The values obtained in Tables 2, conform to the findings of Ayman *et al.*, (2009) [8] who reported that yoghurt concentrated source of essential minerals such are as calcium, potassium, magnesium, phosphorus and zinc. The Table also denote that the process of producing raw milk to yoghurt, is a good method of milk preservation as the fermentation that took place with the inclusion of the two bacteria, helps to reduce the microbial concentration to less than half of it raw content continents, from 4.63 $x10^4$ in raw milk to 2.10 x 10^4 in yoghurt produced

Table 2: *Mineral and Microbial Composition of Milk Sample used and Yoghurt produced before the addition of Ginger Extract*

	Milk	**Yoghurt**	**SEM**
Calcium (mg /100g)	162.29[b]	240.00[a]	2.67
Potassium (mg /100g)	147.00[b]	397.00[a]	3.56
Magnesium (mg /100g)	53.10[b]	168.67[a]	2.43
Microbial load (cfu /ml)	4.63 x 10^{4a}	2.10 x 10^{4b}	0.07

[abcd]: Means with different superscripts along the rows are significantly different ($p<0.05$)

Tables 3 shows the nutrients composition of ginger extract used in this study. The ginger used had acidity nature with more moisture content as shown in the Table.

Table 3: *Nutrient Composition of Ginger Extract used*

Parameters	Ginger extract
Moisture (%)	83.58
Crude protein (%)	4.88
Fat (%)	3.22
Ash (%)	2.04
Total solids (%)	12.40
Acidity (%)	1.05
pH	3.27

Table 4 describe the proximate composition of yoghurt with inclusion levels of ginger. There were no differences ($p>0.05$) in the moisture content but significant differences occurs for other nutrient composition that were measured. Crude protein and fat decreases as the inclusion increases while ash content increases, especially at 10% ginger inclusion. The protein content decreases fro, 4.79% to 3.97% as the inclusion increases. These values are in contrast with Bakhru (1986) [9] report of 3.20-3.40% protein content in yoghurt produced while increase in ash content were noticed from 0.82% in T_1-0.84% in T_4.

Table 4: *Proximate Composition of Yoghurt at Different Levels of Ginger Inclusion (0%, 5%, 10% and 15%)*

	T_1 0%	T_2 5%	T_3 10%	T_4 15%	SEM
Moisture	83.69	85.31	84.18	85.76	1.28
Crude protein	4.79	4.29	4.59	3.97	0.23
Fat	3.88^{a}	3.80^{a}	3.71^{a}	3.59^{b}	0.03
Ash	0.82^{a}	0.86^{a}	0.81^{ab}	0.74^{b}	0.02
Total solid	16.31^{a}	14.69^{c}	15.82^{b}	14.24^{d}	0.06

^{abcd}: Means with different superscripts along the rows are significantly different ($p<0.05$)

There were reductions in the values obtained for ash content as inclusion increases. The addition of ginger to yoghurt help to reduce the fat content to a minimal as the active ingredient which are Shagaol and Gingerol these two are very effective substances which are used in natural or phytochemical antioxidants, as herbal drugs inclusion, positive effects on digestive system Ozgoli *et al.*, (2009) [10], as antidote for seafood intoxication [11], as seasonal /spices [12].

According to Liang (1992) [13], ginger help in treatment of diabetes, high blood pressure, cancer firmness and other illness. It plays curiae roles in oxidation of cholesterol especially low-density Lipoprotein (LDL), as it help to reduce blood lipids and inhibit lipid oxidation.

Gonlachanvit *et al.*, (2003) [14], reported that omen gram of ginger reduced the gastric dysthymia and nausea resulting from the infusion of dextrose to produce hyperglycemia in healthy humans. The inclusion

of ginger to yoghurt production reduces the fat content in yoghurt and therefore made the product more nutritive and of good quality to consumers apart from having lower fat content, it present in the product will add more benefit to consumers when consumed. In Table 4, T_3 performed better with the lowest fat content percentage, the highest ash content and crude protein at different inclusion rate.

Table 5 shows minerals and microbial loads of yoghurt with inclusion level of ginger. There were gradual increase from T_2 to T_3 in all the minerals measured and then decrease from T_3-T_4. Calcium is very important to human being. It is needed for tissue and bone development and adequate calcium intake is important for maintenance of bone health and may reduce risk of osteoporosis. Calcium can be obtained from foods naturally rich in calcium such as milk and dairy foods. It helps nerves conduct messages; muscle contractions; blood clotting; signaling the heart muscle [15]. In table 5, the calcium content of the samples was between 208mg/100g-226.67mg /100g. Calcium was found to be highest in T_1 (226.67mg/100g) with no ginger juice, followed by T_3 (222.67mg/100g), T_2 (211.33mg/100g) and least in T_4 (208mg/100g). It is observed that the calcium content reduced at treatment 2 and increased again at treatment 3 then it finally reduces at treatment 4. The fluctuating effect of ginger on the calcium content of yoghurt may be because of the *gingerol* present in the ginger.

Table 5: *Mineral and Microbial composition of Yoghurt at various levels of Ginger Inclusion*

	T_1 0%	T_2 5%	T_3 10%	T_4 15%	SEM
Calcium (mg/100g)	226.67^{a}	211.33^{bc}	222.67^{ab}	208.00^{c}	2.77
Potassium (mg/100g)	397.00^{b}	389.33^{b}	406.67^{a}	407.67^{a}	3.86
Magnesium (mg/100g)	168.67^{c}	167.33^{c}	182.00^{a}	173.33^{b}	2.53
Microbial load (cfu/ ml)	2.10×10^{4a}	2.03×10^{4b}	1.85×10^{4b}	1.70×10^{4c}	0.06

^{abc}: Means with different superscripts along the rows are significantly different $p<0.0$

Potassium is important in nerve conduction, maintaining water and fluid balance; maintain acid-base balance and muscle contraction. It regulates heartbeat [15]. In table 5, the potassium content of the yoghurt samples was between 389.33mg /100g-407.67mg /100g and was increasing as the ginger juice added was increasing. T_4 was observed to have the highest potassium content (407.67mg/100g) probably because it contained the highest amount of the ginger juice. These high values are in agreement with the findings of Afzal *et al.*, (2001) [16] who reviewed the ethno medical, chemical and pharmacological properties of ginger and discovered it to have high potassium content.

Magnesium is an abundant mineral in the body and is naturally present in many foods. It is required for oxidative phosphorylation, energy production and glycolysis. It contributes to the development of bone and is required for the synthesis of DNA, RNA, and the antioxidant glutathione. Magnesium was observed in the table to be highest in T_3. Magnesium content of the yoghurt samples ranged from 167.33mg/100g -182.00mg/100g. It increased progressively from T_1-T_3 and then decreased at T_4. This is in contrast to the work of Fayeye *et al.*, (2013) [17], who gave the magnesium composition of yoghurt samples to be

11.19mg/100g. It indicate that at 5% of ginger extract inclusion, calcium, potassium and magnesium increases to 10% inclusion while at 15% inclusion decrease in mineral.

The microbial load decreases as the inclusion increases. Microbiological characteristics are indicators of safety, quality and shelf life of prepared yoghurt. Total microbial load of yoghurt samples was determined and result obtained showed that yoghurt samples produced with different levels of ginger juice had lower microbial count than the yoghurt without ginger (T_1) which had the highest microbial load (2.10 x 10^4cfu/ml). This might be associated with the inhibitory nature of ginger extract on bacteria due to the presence of antibacterial compounds such as gingerol, shogaols, Vit. A and B, paradol and zingerene in ginger according to Kolapo *et al.*, (2007) [18]. Similar observations have been reported by Lee *et al.*, (1986) [19] when ginger extract was added to meat products and Oyeniyi *et al.*, (2014) [20] who worked on the effect of flavorings on consumer acceptability of soy-yoghurt and gave the microbial composition of ginger soy - yoghurt to be 1.50 x 10^4 and plain soy-yoghurt to be 1.60 x 10^4 cfu/ml. The active ingredients in ginger reduce the microbial loads in yoghurt from 2.10 - 1.70 x 10^4. Ginger extract in yoghurt production made it healthier for human consumption.

Table 6 shows the palatability status of yoghurt at inclusion level of ginger extract. Colour and texture follows same trend as ginger inclusion increases while the hotness for, follows an inversely direction, meaning as the ginger inclusion increases the hotness of yoghurt increases, the brightest colour (3.80) was obtained by T_1 followed by T_2 (2.40), T_3 (2.20) and T_4 (2.00). T_1 had the thickest texture (3.20) followed by T_2 (2.60), T_3 (2.00) and T_4 (1.60) which had the lightest texture. This is because the addition of ginger juice more than 10% affected the consistency of the yoghurt. T_4 (5.0) was scored the highest for hotness parameter while T_1 (2.0) scored lowest. The yoghurt with 15% ginger (T_4) possessed somewhat loose body and was hotter because of the higher concentration of ginger in it. The ginger juice did not have significant effects on the taste and aroma of the yoghurt samples. However, the highest score for taste was obtained by T_1 (4.40) while the lowest score of 3.20 was obtained by T_4. Significantly highest value for overall acceptability (4.40) was obtained by T_3 with 10 percent ginger juice, followed by T_2 (4.20), and T_1 (4.0) i.e 5% and 0% ginger juice which had no significant difference between them. The lowest value was obtained by T_4 (2.80) with 15% ginger juice.

Table 6: *Palatability Status of Yoghurt at Different Levels of Ginger Inclusions*

	0%	5%	10%	15%	SEM
Colour	3.80^{a}	2.40^{ab}	2.20^{b}	2.00^{b}	0.37
Texture	3.20^{a}	2.60^{ab}	2.00^{b}	1.60^{b}	0.26
Taste	4.40	4.00	3.40	3.20	0.41
Aroma	4.00	4.00	4.00	3.40	0.34
Hotness	2.00^{c}	2.60^{b}	3.00^{b}	5.00^{a}	0.12
Overall acceptability	4.00^{ab}	4.20^{ab}	4.40^{a}	2.80^{b}	0.35

^{abc}: Means with different superscripts along the rows are significantly different ($p<0.05$)

This result was in contrast to the work of Oyeniyi *et al.*, (2014) [20] on ginger soy-yoghurt where the ginger soy-yoghurt was the least preferred in all quality parameters except taste but agrees with the findings of

Adesokan *et al.*, (2010) [21] who evaluated the influence of ginger on "ogi" and discovered that 5% ginger inclusion was the best in all parameters tested. They also reported a longer shelf life for "ogi" containing 10% ginger. It is also in line with the report of [22,23] that yoghurt samples treated with 1% garlic were more favored.

Conclusion

Inclusion of ginger at 10%, improved the nutrients and qualities of yoghurt products, by reducing it fat content, microbial loads and increases the ash (minerals) content with organoleptic properties of the products.

Bibliography

1. FAO (2008). *Milk and dairy products*. Animal Production and Health Division, FAO, Rome.

2. Seckin, K. A., Ergonul, B., Tosun, H. & Ergonul, P. (2009). Effects of prebiotics (inulin and fructooligosaccharide) on quality attributes of dried yoghurt (kurut). *Food Sci. Technol. Res., 15*(6), 605-612.

3. Yadav, A., Jaiswal, P., Jaiswal, M., Kumar, N., Sharma, R., Raghuwanshi, S., Prasad, G. B. K. S. & Bisen, P. S. (2015). Concise review: Importance of probiotics yoghurt for human health improvement. *J. Environ. Sci. Toxicol. Food Technol. (IOSR-JESTFT)., 9*(7), Ver. II, 25-30.

4. Ndife, J., Idoko, F. & Garba, R. (2014). Production and quality assessment of functional yoghurt enriched with coconut. *Int. J. Nutr. Food Sci., 3*(6), 545-550.

5. AOAC (2005). Official Method of Analysis. 15th Edn., Association of official Analytical Chemist, Washingtom D.C.

6. Uzeh, R. E., Uhenhen, R. E. & Rojugbokan, A. K. (2006). Microbiological and nutritional qualities of dairy products: Nono and wara. *Nat. Sci., 4*(3), 37-40.

7. Adewumi, O. O. & Idowu, O. M. (2014). Physicochemical, microbial load and sensory properties of milk, yoghurt with or without garlic. *Nigerian J. Anim. Sci., 16*(1), 166-172.

8. Ayman Sulaiman, M. & Omer Turkmamdoh Ershidat (2009). The benefits of lactic acid bacteria in yoghurt on the gastrointestinal function and health. *Pak. J. Nutrition, 8*(9), 1404-1410.

9. Bakhru, H. K. (1986). Yoghurt for health. The Economic Times Bombay. *The Sunday edition, 25*(5), 5.

10. Ozgoli, G., Goli, M. & Simbar, M. (2009). Effects of ginger capsules on pregnancy, nausea, and vomiting. *The Journal of Alternative and Complementary Medicine, 15*(3), 243-246.

11. Uniacke-Lowe, T., Huppertz, T. & Fox, P. F. (2010). Equine milk proteins: chemistry, structure and nutritional significance. *Int. Dairy J., 20*(9), 609-629.

12. Ghada (2005). Comparison of chemical & mineral contents of milk from human, cow, buffalo, camel & goat in Egypt. *The Egyptian journal of hospital medicine, 21*(1), 116-130.

13. Laing, M. H. (1992). From America: cookbook medicine or food for thought: practice guidelines development in USA. *Annals of the Rheumatic Diseases, 51*(11), 1257-1258.

14. Gonlachanvit, S., Chen, Y. H., Hasler, W. L., Sun, W. M. & Owyang, C. (2003). Ginger reduces hyperglycemia evoked gastric dysrhythmias in health humans: Possible role of endogenous prostaglandins. *J Pharmacol Exp Ther., 307*(3), 1098-1103.

15. FAO/WHO. (1996). Probiotics in food: Health and nutritional properties and guidelines for evaluation. Expert consultation on evaluation of health and nutrition properties of probiotics in food including powder milk with live lactic acid bacteria.

16. Afzal, M., Al - Harida, D., Menon, M., Peek, J. & Dhami, M. (2001). Ginger; an ethno medical, chemical and pharmacological review. *Drug Metabol. Drug Interact., 18*(3-4), 159-190.

17. Fayeye, T. R., Badmos, A. H. A. & Okin, H. O. (2013). Milk yield and quality of Holstein and Jersey breeds of cattle in Kwara State, Nigeria. *J. Agric. Res. & Dev., 12*(1), 11-18.

18. Kolapo, A. L., Popoola, T. O. S., Sunni, M. O. & Afolabi, R. O. (2007). Preservation of soybean daddawa condiment with dichloromethane extract of ginger. *Res. J. Microbiol., 2*(3), 254-259.

19. Lee, Y. K. & Salminen, S. (2008). *Handbook of probiotics*, second edition. John Wiley & Sons. Hoboken, NJ. (pp. 441-443).

20. Oyeniyi, A. O., Aworh, O. C. & Olaniyan, J. O. (2014). Effects of flavourings on quality & consumer acceptability of soy - yoghurt. *Journal of Environmental science, Toxicology and food Technology (IOSR JESTIFF), 8*(1), ver III, 38-44.

21. Adesokan, I. A., Abiola, O. P. & Ogundiya, M. O. (2010). Influence of ginger on sensory properties and shelf - life of 'Ogi', a Nigerian traditional fermented food. *African Journal of Biotechnology, 9*(12), 1803-1808.

22. Gundogdu, E., Songul, C. & Elif, D. (2009). The effect of garlic (Allium sativum L.) on some quality properties and shelf-life of set and stirred yoghurt. *Turkish Journal of Veterinary and Animal Sciences, 33*(1), 27-35.

23. Beauchamp, K. (2004). *Yogurt prevents antibiotic-associated diarrhea*. Bastyr Center for natural health.