Effects of different autoclaving parameters on the nutritional compositions of raw milk samples

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Abstract: As milk provides a substantial amount of vitamins and minerals in relation to its energy content, it is considered a nutrient dense food.The difference and changes in the nutritional compositions (Protein, fat, carbohydrate, moisture content, ash content, fibre content, magnesium and calcium) of White Fulani, Sokoto Gudali and mixture of the two breeds were investigated before and after autoclaving of milk samples in glass, aluminium and stainless steel containers at various temperatures of 110℃ ,121℃and 130℃ with autoclaving time of 10minutes, 20 minutes and 30 minutes. The heat treatment was done using MA-DONAX YX-280A Vertical Column Autoclave of 18Litre capacity of pressure of 0.14MPa – 0.165MPa.The results were evaluated using ANOVA at $p \leq 0.05$. The significant difference was evaluated using the DNMRT.Chemical test carried out on the samples before and after autoclaving showed significant variation in (Protein, fat, carbohydrate, moisture content, ash content, fibre content, magnesium and calcium content ($p<0.05$) after autoclaving. Carbohydrate content in milk increases at 30mins for all the temperature and materials, carbohydrate content in white Fulani 9.56% is higher than other milk source. Moisture content reduced for all conditions with no preference to any autoclaving parameter. Both calcium and magnesium reduced for all milk samples (12.38%, 12.92%, 12.83%) and (7.90%, 5.89%, 4.24%) respectively. At higher temperature of 130C the fat content in milk decreases in both glass material and stainless steel which makes aluminium a preferable storage material.

Keywords: breeds, milk, nutritional, temperature, time

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1 Introduction

The exact component of raw milk varies by species, but it contains significant amount of organic acids, vitamin A, B12, D, riboflavincalcium, carbohydrates, phosphorous, selenium, magnesium, zinc, proteins, bioactive peptides and oligosaccharides (Mohammed et al., 2017). On average, mineral elements account for 4% of total body mass and part of every tissue, liquid, cell and organ in human body. There is a sufficient evidence that minerals, both independently or in proper balance with other minerals, have structural, biochemical and nutritional functions that are very important for overall human health, both mental and physical (Zamberlinetal., 2010). The composition of milk varies among mammals, primarily to meet growth rates of the individual species (AlcázarChirlaque, 2011). Milk has been part of our staple diet since the agricultural revolution, so eliminating its consumption has nutritional consequences. Milk supplies an economical source of nutrients and confers numerous health benefits: it plays a critical role in nutrition and health (Harden and Hepburn, 2011).

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Considering the innumerable health benefits of cow‘s milk, knowing about its nutritional value will be highly helpful (AlcázarChirlaque, 2011). Also, milk and milk products are main constituents of the daily diet, especially for vulnerable groups such as infant’s school age children and old age (Gasmallaet al., 2013)

Dairy food should be encouraged as part of varied and nutrition diet as they help to maintain healthy bones, dental health and balanced nutritional life. Milk has been part of the human diet for millennia and is valued as a natural and traditional food and is considered to be one of the main food groups important in a healthy balanced diet (FSA, 2010). Milk is a major source of dietary energy, protein and fat, contributing on average 134 kcal of energy/capita per day, 8 g of protein/capita per day and 7.3 g of fat/capita per day in 2009 (FAOSTAT, 2012). Water is the main component in all milks, ranging from an average of 68% in reindeer milk to 91% in donkey milk. The main carbohydrate is lactose, which is involved in the intestinal absorption of calcium, magnesium and phosphorus, and the utilization of vitamin D. Lactose also provides a ready source of energy for the neonate, providing 30% of the energy in bovine milk, nearly 40%in human milk and 53–66% in equine milk (Fox, 2008).

Milk as a raw material has a relatively short shelf life but it can be prolonged by heat treatment, which is an essential step adopted by the dairy industry (Raikos, 2010).Heat treatment is the most common way of preserving milk and make it safe. The main goals of heating are killing pathogenic microorganisms, inactivating most (>95%) spoilage organisms and inactivating enzymes, native to milk or excreted by microorganisms, responsible for the reduction of milk keeping quality. The most common heat treatments widely used in the dairy industry to achieve milk safety and preservation are pasteurization and UHT (ultra-high temperature) sterilization, thermizationand in-bottle sterilization are also performed on raw milk. Basically, the above-mentioned heating treatments differ in the heat loads, specifically in the temperature and duration of heating. The choice of the heat treatment to be applied mainly depends on a trade-off among milk safety, extent of milk shelf-life and changes in milk quality. The heat load necessary to achieve milk safety depends, at its turn, on the microbiological quality of raw milk and on the growth potential of spore-forming bacteria after heating (Melini et al., 2017; Barker and Goméz-Tomé, 2013; Ozer and Akdemir-Evrendilek, 2015; Kelly et al., 2006)

An autoclave is a pressure chamber used to carry out industrial processes requiring elevated temperature and pressure different to ambient air pressure. Autoclave isused in medical application to perform sterilization, and in the chemical industry to cure coatings, vulcanize rubber and for hydrothermal synthesis. The followings are the various conditions required for carrying out autoclaving process at different stages.It involves taking trial under “loaded condition”. The calibration of instruments, apparatus carried out at suitable intervals in accordance with an established written program containing specific directions, schedules, limits for accuracy and precision. Operating range, approval standard operating procedure is used for verification. Performance qualification is integrate, procedure, personal, system and material verify pharmaceutical grade utility, and environment, equipment, and system produce required output. Autoclaving is one of the heat treatment that has been proven to be very effective in milk preservation, it is certain that heating of milk usually brings about a change in the milk content as well as its nutritional values. Hence, the need arises to preserve milk and also maintain all of its very important quality and content. Autoclaving which uses heat for milk preservation is then analyzed on two different breeds of cows, and also on the two breeds combined as one to discover which has a higher percentage of certain nutrients.

As a result of low shelf life of milk, there is need to consider alternative means of preserving milk that will be easy and safe to perform, prolong the life span of milk and retain its nutritional values. Preserving of milk through heat treatment, and in so doing maintaining all its quality and nutritional content is very pivotal. Hence the use of autoclaving is tested on various samples of milk and then analyzed.The main aim of this study is to determine the effect of different autoclaving parameters on the nutritional composition of raw milk samples.

2Material and methods

2.1Material collection and packaging material selection

The materials were selected based on the need, relative availability, cost and engineering properties. The milk sample were gotten from the local herdsman in GaaBolorunduro, in Ilorin and classified according to the breed of the cattle (White Fulani and SokotoGudali).The materials used for holding milk in autoclaves includes stainless steel, aluminium and glass material.

2.2Milk sample collection

The milk samples (White Fulani and SokotoGudali) which is sourced from two different breeds of cow was collected locally from herdsmen in the environs.The standard procedure was followed for the milk collection. The collected warm milk was poured in a container and refrigerated at less than 4℃with aid of sufficient ice pack. The milk was then conveyed to the laboratory and refrigerated while the set-up of the machine was on for autoclaving.

2.3General description of experimental setup

The experimental or design setconsist of different materials (aluminium, stainless steel and glass jar) in which the milk was poured for autoclaving. The materials were sterilized at a temperature above 100 ℃ for 10minutes before pouring the milk. Each vessel was in three places to accommodate the three different breeds of raw milk samples (White Fulani, SokotoGudali and the mixture of the breed). The three vessels were arranged in the autoclave at once before closing the autoclave. The temperature and pressure meter on the autoclave cover was used to monitor the required temperature with stop watch for time monitoring. The temperature meter displays the temperature inside the autoclave during operation with the aid of thermometer connected. These parameters were completely randomized and varied within and across their levels (with 81 runs) replicated three times at each parameter’s level.

2.4Determination of nutritional composition

After autoclaving, the temperature of the milk samples was allowed to fall to room temperature and moved to the laboratory to test for the nutritional compositions of the milk samples. The samples remained refrigerated and then moved to the laboratory to determine the nutritional compositions of raw milk samples. These were determined in the laboratory using (AOAC, 2002) nutritional guidelines. The nutritional values determined were magnesium, calcium, ash content, protein, carbohydrate, fibre content, moisture content and fat content.

3Results and discussion

Table 1 shows the summary statistics while Table 2 shows the ANOVA for the effect of materials, applied temperature, autoclaving time and source of milk on the nutritional compositions of autoclaved milk.

3.1Protein content

The result shows that protein content in White Fulani milk decreased significantly by 7.90% ,7.83%, and7.80% in glass, aluminium and stainless steel respectively at the highest autoclaving time of 30 mins at 110℃ The same was noticed for temperatures of ℃120℃and 130℃, at higher autoclaving time of 30mins the protein contents reduces drastically. This could be attributed with sterilization process under which denaturation of protein could occur due to higher temperature (110℃). These findings corroborate the results of Fetahagićet al.(2002), who found that nitrogen content decreased with increase in temperature due to denaturation of protein that resulted decreased protein content of treated milk samples. This statement is further justified by the values obtained for the protein content of milk from the mixture of breeds at certain temperature and time (7.88% at 130℃ in glass, 7.74% at 130℃ in aluminium and 7.80% in stainless steel at 30mins).

Table 1 Summary statistics of the data generated

Response variable				Glass								Aluminium								Stainless Steel							
T	S	Timing		%Carb	%Prot	%Fat	%AshC	%FibrC	%MC	%Cal	%Mag	%Carb	%Prot	%Fat	%AshC	%FibrC	%MC	%Cal	%Mag	%Carb	%Prot	%Fat	%AshC	%FibrC	%MC	%Cal	%Mag
110	1	10	Mean	9.28	7.95	7.69	1.29	0.25	73.58	12.02	2.43	9.40	7.86	7.64	1.35	0.27	73.48	16.03	3.88	9.53	7.84	7.62	1.34	0.29	73.38	12.02	3.40
			SD	0.01	0.02	0.02	0.03	0.02	0.03	0.04	0.04	0.02	0.04	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.04	0.02	0.03	0.02	0.02
		20	Mean	9.33	7.92	7.64	1.28	0.28	73.55	10.42	3.89	9.48	7.84	7.62	1.34	0.28	73.79	16.83	3.88	9.60	7.82	7.61	1.33	0.27	73.37	14.42	2.91
			SD	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.56	0.02	0.01	0.04	0.02	0.02	0.02	0.04	0.04	0.01	0.02
		30	Mean	9.34	7.90	7.63	1.30	0.29	73.55	9.62	5.35	9.50	7.83	7.60	1.33	0.29	73.45	15.23	4.38	9.66	7.80	7.59	1.32	0.28	73.35	13.63	5.35
			SD	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.02
	2	10	Mean	9.23	7.92	7.64	1.33	0.30	73.58	9.62	4.38	9.48	7.88	7.63	1.36	0.25	73.40	16.03	4.38	9.52	7.82	7.65	1.33	0.26	73.42	10.42	3.16
			SD	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.07	0.02	0.02	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.02	0.02
		20	Mean	9.29	7.96	7.62	1.32	0.31	73.50	12.02	6.04	9.46	7.86	7.64	1.34	0.27	73.43	16.83	4.38	9.55	7.80	7.64	1.34	0.27	73.40	12.02	4.86
			SD	0.01	0.02	0.03	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.02	0.05	0.02	0.04	0.04	0.02	0.04	0.02	0.02
		30	Mean	9.31	7.91	7.61	1.30	0.33	73.55	11.22	5.11	9.49	7.82	7.62	1.32	0.29	73.46	13.63	7.29	9.60	7.80	7.62	1.34	0.28	73.36	11.22	3.40
			SD	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.01	0.01	0.03	0.03	0.01	0.01	0.02	0.02	0.02
	3	10	Mean	9.30	7.94	7.65	1.28	0.30	73.53	14.43	5.83	9.48	7.80	7.60	1.38	0.28	73.48	14.43	6.32	9.52	7.88	7.65	1.31	0.24	73.40	12.83	6.32
			SD	0.01	0.02	0.02	0.02	0.04	0.02	0.01	0.02	0.10	0.08	0.08	0.02	0.02	0.02	0.02	0.01	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		20	Mean	9.34	7.92	7.63	1.27	0.32	73.52	16.83	2.92	9.49	7.81	7.63	1.39	0.30	73.40	16.83	6.32	9.55	7.86	7.63	1.36	0.23	73.37	14.42	5.40
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.03	0.01	0.02	0.01	1.73
		30	Mean	9.43	7.88	7.60	1.29	0.30	73.51	10.42	5.83	9.50	7.80	7.70	1.37	0.27	73.41	15.23	5.83	9.54	7.84	7.65	1.35	0.27	73.35	14.83	5.59
			SD	0.02	0.02	0.02	0.02	0.02	0.01	0.04	0.02	0.02	0.02	0.19	0.14	0.06	0.08	0.08	0.02	0.02	0.02	0.02	0.02	0.00	0.01	0.02	0.02
121	1	10	Mean	9.22	7.96	7.67	1.30	0.29	73.56	12.02	4.38	9.51	7.80	7.60	1.31	0.25	73.44	14.43	5.35	9.57	7.86	7.63	1.30	0.25	73.39	12.83	4.13
			SD	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.08	0.06	0.06	0.03	0.06	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.02
		20	Mean	9.23	7.94	7.64	1.33	0.33	73.53	12.83	4.38	9.55	7.78	7.65	1.33	0.26	73.43	13.63	7.29	9.54	7.84	7.64	1.34	0.26	73.38	14.42	4.13
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.10	0.13	0.05	0.05	0.03	0.05	0.04	0.01	0.02	0.02	0.02	0.04	0.02	0.02	0.01	0.05
		30	Mean	9.28	7.92	7.63	1.32	0.35	73.50	12.02	5.83	9.56	7.76	7.63	1.36	0.27	73.40	12.83	7.29	9.56	7.82	7.65	1.35	0.28	73.34	12.83	5.34
			SD	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.10	0.10	0.02	0.04	0.08	0.02	0.01	0.02	0.02	0.02	0.05	0.01	0.02	0.02	0.02
	2	10	Mean	9.21	7.95	7.65	1.32	0.30	73.57	13.63	6.81	9.45	7.80	7.65	1.34	0.26	73.50	16.83	6.32	9.53	7.84	7.60	1.36	0.27	73.40	12.02	6.81
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.10	0.05	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.03
		20	Mean	9.27	7.93	7.63	1.31	0.32	73.54	15.23	6.32	9.52	7.74	7.64	1.38	0.24	73.48	16.03	4.38	9.51	7.85	7.62	1.35	0.28	73.39	13.63	6.32
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.03	0.07	0.04	0.08	0.03	0.08	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.04	0.02
		30	Mean	9.29	7.92	7.64	1.32	0.30	73.53	13.63	6.32	9.50	7.79	7.65	1.35	0.25	73.46	14.43	6.32	9.57	7.80	7.65	1.33	0.28	73.37	15.23	3.40
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.03	0.08	0.02	0.02	0.02	0.05	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.05	0.02
	3	10	Mean	9.28	7.94	7.65	1.29	0.29	73.55	12.02	5.83	9.49	7.82	7.63	1.36	0.23	73.47	15.23	7.29	9.54	7.86	7.63	1.36	0.26	73.35	14.42	5.35
			SD	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.03	0.04	0.02	0.05	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.02
		20	Mean	9.32	7.92	7.62	1.31	0.30	73.53	12.83	5.34	9.47	7.78	7.65	1.39	0.26	73.45	14.42	6.81	9.53	7.82	7.66	1.35	0.27	73.37	13.63	4.38
			SD	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.10	0.02	0.04	0.03	0.03	0.01	0.01	0.02	0.02	0.04	0.02	0.01	0.02	0.04	0.02
		30	Mean	9.34	7.90	7.61	1.32	0.31	73.52	13.63	2.43	9.51	7.74	7.67	1.38	0.27	73.43	15.23	4.86	9.52	7.88	7.67	1.30	0.28	73.34	16.03	4.86
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.07	0.02	0.02	0.02	0.05	0.02	0.03	0.02	0.02	0.02	0.01	0.04	0.04	0.02
13	1	10	Mean	9.29	7.93	7.63	1.30	0.30	73.55	12.83	5.35	9.54	7.80	7.64	1.33	0.25	73.44	14.42	4.86	9.50	7.86	7.60	1.37	0.27	73.40	10.42	5.35

0			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.10	0.01	0.02	0.02	0.06	0.02	0.01	0.01	0.02	0.02	0.03
		20	Mean	9.31	7.92	7.63	1.32	0.28	73.54	14.43	5.83	9.56	7.78	7.64	1.37	0.24	73.42	16.03	7.29	9.54	7.84	7.59	1.39	0.25	73.39	10.42	3.40
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.04	0.03	0.02	0.02	0.05	0.04	0.04	0.01	0.02	0.02	0.02	0.02	0.01	0.04	0.02	0.02
		30	Mean	9.34	7.91	7.60	1.30	0.32	73.53	15.23	4.86	9.57	7.76	7.65	1.36	0.26	73.40	16.43	5.83	9.57	7.80	7.60	1.36	0.27	73.38	10.42	2.92
			SD	0.02	0.02	0.02	0.02	0.02	0.02	0.05	0.02	0.02	0.04	0.05	0.06	0.10	0.04	0.05	0.02	0.04	0.02	0.06	0.02	0.01	0.01	0.02	0.02
		10	Mean	9.24	7.95	7.65	1.32	0.29	73.56	12.83	4.38	9.48	7.78	7.68	1.34	0.28	73.44	13.63	7.29	9.50	7.88	7.62	1.34	0.25	73.41	12.02	4.38
			SD	0.03	0.05	0.02	0.06	0.02	0.04	0.02	0.02	0.04	0.04	0.04	0.06	0.08	0.04	0.04	0.01	0.02	0.02	0.03	0.04	0.03	0.01	0.02	0.02
	2	20	Mean	9.26	7.94	7.63	1.33	0.31	73.53	13.63	6.32	9.47	7.77	7.67	1.35	0.25	73.46	15.23	7.29	9.52	7.86	7.61	1.37	0.26	73.38	15.23	3.89
			SD	0.02	0.04	0.02	0.04	0.02	0.02	0.02	0.07	0.02	0.07	0.07	0.05	0.04	0.08	0.05	0.01	0.02	0.04	0.05	0.01	0.02	0.01	0.05	0.02
		30	Mean	9.27	7.92	7.62	1.35	0.32	73.52	14.43	7.29	9.56	7.72	7.65	1.36	0.27	73.44	11.22	6.50	9.55	7.86	7.62	1.38	0.27	73.36	13.63	3.40
			SD	0.04	0.02	0.02	0.02	0.04	0.02	0.02	0.01	0.03	0.02	0.05	0.02	0.02	0.04	0.02	1.14	0.05	0.02	0.02	0.02	0.01	0.02	0.04	0.02
		10	Mean	9.21	7.94	7.65	1.33	0.30	73.57	10.42	3.40	9.47	7.78	7.63	1.35	0.26	73.51	14.42	7.78	9.57	7.84	7.60	1.36	0.29	73.38	12.02	3.65
			SD	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.02	0.03	0.05	0.05	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.02
	3	20	Mean	9.27	7.90	7.64	1.34	0.31	73.54	11.22	2.92	9.42	7.76	7.66	1.38	0.28	73.50	16.03	7.29	9.56	7.82	7.62	1.37	0.30	73.37	12.02	5.83
			SD	0.02	0.02	0.04	0.04	0.02	0.02	0.02	0.02	0.06	0.01	0.02	0.01	0.08	0.02	0.04	0.01	0.05	0.02	0.02	0.01	0.02	0.02	0.02	0.04
		30	Mean	9.30	7.88	7.63	1.34	0.32	73.53	13.63	3.65	9.50	7.74	7.64	1.37	0.27	73.48	15.23	4.86	9.58	7.80	7.63	1.36	0.32	73.36	12.02	4.71
			SD	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.04	0.06	0.10	0.02	0.02	0.02	0.05	0.02	0.01	0.02	0.02	0.01	0.02	0.04	0.02	0.63

Note: T-temperature, S-milk source (white fulani=1, sokotogudali=2, & mixture=3).

Table 2 Multivariate analysis of variance Test on the effect of process parameter on proximate &anti-oxidants

Material		DV	Carb	Prot	Fat	AshC	FibrC	MC	Cal	Mag
	T	F	41.27	1.59	0.60	9.66	2.05	0.34	25678.89	3562.40
		Sig.	0.000	0.214	0.551	0.000	0.139	0.711	0.000	0.000
	S	F	38.43	5.05	1.38	4.07	1.41	1.66	3770.62	23725.96
		Sig.	0.000	0.010	0.261	0.023	0.253	0.200	0.000	0.000
	T	F	90.57	18.00	18.45	0.80	8.12	21.02	13216.66	1610.60
		Sig.	0.000	0.000	0.000	0.453	0.001	0.000	0.000	0.000
Glass	T*S	F	26.95	0.69	4.18	2.95	4.80	3.87	41629.72	7220.61
		Sig.	0.000	0.605	0.005	0.028	0.002	0.008	0.000	0.000
	T*t	F	1.97	0.71	0.83	0.82	0.56	1.23	20475.58	3828.19
		Sig.	0.113	0.591	0.513	0.518	0.694	0.309	0.000	0.000
	S*t	F	3.07	1.35	0.52	0.50	1.19	1.35	2466.44	6069.19
		Sig.	0.024	0.264	0.725	0.737	0.326	0.262	0.000	0.000
	T*S*t	F	2.46	0.72	0.46	0.81	1.04	1.07	10849.52	5953.96
		Sig.	0.024	0.677	0.879	0.595	0.416	0.399	0.000	0.000
	T	F	4.53	12.60	0.73	0.05	2.12	0.43	5482.41	284.80
		Sig.	0.015	0.000	0.488	0.950	0.130	0.655	0.000	0.000
	S	F	5.28	1.04	0.72	3.87	0.19	0.22	632.12	92.88
		Sig.	0.008	0.360	0.491	0.027	0.826	0.807	0.000	0.000
	T	F	6.66	3.92	0.36	0.93	0.56	1.11	9369.11	6.23
		Sig.	0.003	0.026	0.701	0.400	0.574	0.337	0.000	0.004
Aluminum	T*S	F	4.69	0.88	0.26	0.46	0.38	2.89	8622.50	107.66
		Sig.	0.003	0.479	0.904	0.767	0.824	0.030	0.000	0.000
	T*t	F	0.94	0.28	0.16	0.86	0.19	0.60	3222.22	84.66
		Sig.	0.446	0.893	0.960	0.493	0.942	0.663	0.000	0.000
	S*t	F	1.27	0.05	0.75	0.20	0.43	1.13	4704.03	196.14
		Sig.	0.294	0.996	0.565	0.935	0.785	0.353	0.000	0.000
	T*S*t	F	0.92	0.50	0.49	0.19	0.30	1.06	874.26	33.99
		Sig.	0.505	0.847	0.861	0.992	0.964	0.402	0.000	0.000
	T	F	5.08	1.99	7.84	12.27	2.00	1.47	32948.37	34.54
		Sig.	0.010	0.146	0.001	0.000	0.146	0.240	0.000	0.000
	S	F	5.41	2.10	4.96	0.20	0.49	5.38	13839.13	58.52
		Sig.	0.007	0.132	0.010	0.818	0.618	0.007	0.000	0.000
	T	F	14.92	10.72	0.78	2.46	7.25	13.48	18785.49	8.55
		Sig.	0.000	0.000	0.464	0.095	0.002	0.000	0.000	0.001
Stainless	T*S	F	6.92	9.75	2.02	0.78	12.08	1.47	25703.82	31.90
		Sig.	0.000	0.000	0.105	0.544	0.000	0.225	0.000	0.000
	T*t	F	4.49	0.43	2.49	0.63	0.47	0.71	2467.99	11.81
		Sig.	0.003	0.786	0.054	0.644	0.758	0.586	0.000	0.000
	S*t	F	3.45	1.35	0.55	0.40	1.18	0.42	4411.58	34.18
		Sig.	0.014	0.264	0.696	0.806	0.332	0.793	0.000	0.000
	T*S*t	F	1.09	1.81	0.37	2.83	0.65	0.52	3062.82	33.96
		Sig.	0.383	0.096	0.929	0.011	0.733	0.836	0.000	0.000

Note: *significant at 5% level.

These findings also agreeing with work of (Miyamoto et al.,2009) who stated that temperature above the level of 60 ℃ results in denaturation of protein content thus decreases the level of protein in treated samples. It has also been reported that at higher temperature of 105^0-120 ℃ denaturation of whey protein structure occurs (Melini et al., 2017). Hence higher autoclaving time and temperature significantly decreased protein irrespective of the storage material.

3.2Carbohydrate contents

The carbohydrate content from the result of the analysis show that carbohydrate seems to decrease with the first two higher levels of temperature in glass and stainless-steel materials but increases with higher levels of temperature in aluminum materials. It was observed that at temperature of 121℃, the carbohydrate content in glass and stainless steel decreased slightly at 9.55%, 9.54% and 9.53% for the mixture of milk while there is no noticeable fall in the carbohydrate content of white Fulani and SokotoGudali. As true as this is for stainless and glass material, aluminuimopposes these statements as an increase in carbohydrate content is noticed in aluminium material. UlHaqet al.(2013) researched that increase in temperature slightly increased the lactose content in thermizide and pasteurized milk samples. These findings agree with the results of Nangraj (2011) and Hussain (2011), who stated that lactose content in milk samples pasteurized at various temperatures was slightly higher than that of control. But it started to decrease in sterilized milk because of lactose degradation, resulting in decreasing the lactose content, which agreed with work reported by Siddiqueet al. (2010) and Cattaneoet al. (2008), who found that more lactulose (an intermediate product of lactose break down) is formed in heat treated milk, resulted in lowering of the lactose content of milk samples treated at higher temperatures

3.3Fat content

Also from the analysis, it was observed that the fat content decreased drastically at temperatures of 110℃and 121 ℃ at the highest autoclaving time for all the materials(glass, aluminium and stainless steel) but a trend is noticed that at a higher temperature of 130℃ the fat content increased in stainless steel 7.60%, 7.62% 7.68% and also aluminium 7.63%, 7.66%.7.64% for mixture of breed. The results showed that increase in temperature slightly increased the fat content of milk samples as a result of crossbreed. These findings are in agreement to the results by Nangraj (2011) and Abubakaret al. (2001), who reported that increase in temperature, resulted in slight increase in fat content. This is further supported by Petrus et al. (2011) and Winarsoand Foekh (2011), who reported that changes in chemical composition of fat could occur at higher temperatures under which a level of milk fat slightly reduced from that of fresh milk due to evaporation of some components of milk during heating process.

3.4Moisture content

It was also observed in the analysis that moisture content decreased irrespective of the storage material and the milk source, as the temperature and autoclaving time increases, the moisture content decreases. The present findings showed that increase in temperature resulted in decreasing the moisture level of milk samples. These results are in accordance with the observations by Nangraj (2011), who resulted that increasing temperature caused some of the moisture to evaporate and thus resulted in decreasing the moisture content of treated milk.

3.5Ash content

The ash was slightly increased as temperature was increased, the results supports the findings by Hussain (2011), who found that heating of skimmed milk samples resulted in increasing the ash content. These findings are in cross with the results by Siddiqueet al. (2010), stated that there was no significant difference in milk samples treated at various temperatures.

3.6Minerals content

Minerals (calcium and magnesium) of milk reduces with respect to time, temperature and storage material. The loss of calcium depends on the quality of fresh milk and physical-chemical parameters. (Šestan et al., 2016). Fibre content increased with increasing temperature, this agrees with the work of (Ikyaet al., 2013) whose research shows a significant increase in crude fibre, with increase in processing temperature.

4Conclusions

This research focused on the effect of different autoclaving parameters on the nutritional compositions of raw milk samples, the following conclusions were drawn from the study.

(1) Carbohydrate content in milk increases at 30minsfor all the temperature and materials. Carbohydrate content in white Fulani 9.56% is higher than other milk source. Fat content generally has a lower value in White Fulani and SokotoGudali but has a higher value in the mixture. At higher temperature of 130℃ the fat content in milk decreases in both glass material and stainless steel with an exception for aluminium which increases. There was a general decrease in protein content in all the milk samples with respect to time, temperature and material but in glass material, it reduced minimally and it has a higher value in glass compared to stainless steel and aluminium.

(2) Ash content seem to increase at higher temperature of 130℃ and reduced at a lower temperature of 121℃ and 110℃. It has a higher value in the mixture of breed compared to white Fulani and sokotogudali. Aluminuim and stainless steel is better than glass material for ash content.There was a severe decrease in fibre content of sokotoguadli and the mixture at a higher temperature in stainless steel and aluminuim compared to white Fulani whose fibre content increase. Generally, moisture content reduced with respect to time, milk source and temperature. Glass material tends to retain moisture content than other materials therefore it is most suitable of the materials of the time and temperature.

(3) Minerals (calcium and magnesium) in milk is highest in aluminium material compared to glass and stainless steel which reduced outrageously. Calcium content is best in white Fulani and it changes with respect to time and temperature. At the first two higher temperatures of 121℃ and 130℃ the calcium content increases same in the case of Magnesium.

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