International Journal of Advanced Research in Chemical Science (IJARCS)
Volume 1, Issue 10, December 2014, PP 31-37
ISSN 2349-039X (Print) & ISSN 2349-0403 (Online)
www.arcjournals.org

Assessment of Some Diary Products Sold in Sokoto Metropolis, Nigeria

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Abstract: *The milk and meat of some animals in Sokoto metropolis were assessed. The heavy metals in fresh milk and meat of four species of animals were also determined. Eight samples each of the milk and meat of the four species of animals (camel, cow, goat and sheep) were randomly collected at the abattoir and market place at the early morning hours. The samples collected were analyzed for determination of lead, cobalt, chromium, manganese, zinc, copper, nickel, mercury, barium, cadmium and iron contents. The results show that the milk and meat of the animals may be safe for consumption as most of the toxic metals like mercury, lead, nickel and cobalt were not detected while some essential elements and other metals like calcium, phosphorus, potassium, sodium, zinc, copper, iron and cadmium did not exceed the recommended permissible limit in the sample except for camel meat that exceeded the potassium permissible limit. The health importance of the results obtained is that in as much as it is good to avoid heavy metal poisoning, it is required that the essential metals be present in at least the minimum requirement for the normal body physiological processes to effectively take place.*

Keywords: *nutrition, heavy metals, food chain, grazing land*

1. INTRODUCTION

Heavy metals are persistent as contaminant in the environment and come to the fore front of dangerous substances causing health hazard in human. Industrial and agricultural processes have resulted in an increased concentration of heavy metals in air, water, soil and subsequently, these metals are taken by plants or animals and take their ways into food chain (Ahmad, 2002).

Meat and milk of animals are among the most proteinous foods consumed in high quantity both for their nutritional value and appetizing taste. The presence of heavy metals in these dairy products may be attributed to the contamination of the diary products during lactation, through feeding stuff, pesticides and water (Carl, 1991). It could also be through manufacturing processes (Ukhun *et al*., 1990) or through anthropogenic sources (Okada *et al*., 1997).

Whichever way, the effects are not pleasant. The British Broadcasting Cooperation (BBC, 2010) reported that about four hundred death and over 200 children hospitalized in many clinics, while Cable News Network (CNN, 2010) reported death toll still rising as many more are assumed dead. These reports and many more are from a single case of lead poisoning in Anka and Bungudu Local Government Areas of Zamfara State, Nigeria. This occurred as a result of illegal mining of gold and the eventual dumping of lead contaminated soil in the environment and most significantly in the water bodies around this area. Drinking water from such water bodies could lead to lead poisoning.

Many illegal mining of gold, tin and other metals in Nigeria abound. It has been found that extraction or mining of one metal could lead to the release of one or more other metals in its free or combined state. Illegal miners are usually not professionals with sophisticated machines and so these other metals are usually not properly disposed off or channeled to a safer use leading to their various metal poisoning. The cumulative and persistent nature of these heavy metals make them more toxic and the fact that the symptoms of such metal poisoning are similar to symptoms of

common diseases like malaria, typhoid, etc make it almost impossible to be detected on time (Independent News and Media, 2010).

In most cases of such metal poisoning, human beings are the major concerns while little or no attention is paid to the affected animals. The irony of it is that most of our diets are gotten from these animals and so we eventually consume them with heavy metals in them and so increase the concentration of the heavy metals in us because of the persistent and cumulative nature of these metals.

2. MATERIALS AND METHODS

In all the preparations of solutions, chemicals of analytical reagent grade and distilled water were used.

Sizeable chunk of freshly slaughtered cow, goat, sheep and camel were collected, from the Sokoto abattoir. They were kept in a Teflon(TM) bag and stored in a refrigerator for further processes.

Fresh milk of ewe, cow, sheep and camel were collected during the morning milking hours in a Teflon(TM) container with ice blocks inside and immediately transported to the experimental site.

3. EXPERIMENTAL

2g of each sample were taken and put into a microgender tube. 10mls of concentrated nitric acid (HNO3) (S.G 1.42, purity 97%) and 2ml of concentrated perchloric acid (HClO3 72%, SG 1.7) was added into the gender tube and heated in a fume cupboard for 10 – 15 minutes until the brown fumes disappeared and white fumes were now coming out which indicated complete digestion. It was removed and kept in a microgender rack to cool. After cooling, it was poured into a 50ml volumetric flask and filled to the mark with distilled water. It was then filtered and stored in a Teflon(R) bottle to be analyzed using AAS.

Proximate analysis of the samples was determined according to the standard methods as recommended by the Association of Official Analytical Chemists (AOAC, 1990). Atomic Emission Spectroscopy (AES) was used to determine the quantity of sodium and potassium present in the sample. Phosphorus content of the sample was determined calorimetrically using AOAC (1990).

The sample was nebulized into an air-acetylene flame where it was vaporized. The compounds were then atomized and the atoms found absorb radiation of the characteristics wavelength from the hollow-cathode lamp. The absorbance measured, was proportional to the amount of analyte in the sample solution in accordance with Beer-Lambert's law. The concentration of the analyte was calculated using equation below:

$$x\ (mg/100g) = \frac{x(mg/kg) \times \text{volume of sample} \times 10}{\text{Weight of sample}}$$

4. STATISTICAL ANALYSIS

All determinations were replicated three times and results were reported as mean + standard deviation.

5. RESULT AND DISCUSSION

Table1. *Result of Proximate Analysis*

Sample	% Moisture content	% Ash Content	Specific Gravity	% Lactose	% Total Solid	% Total fat	% Crude protein	% Acidity
Milk	87.73 ± 0.64	0.53 ± 0.12	1.12 ± 0.01	6.32 ± 0.06	13.43 ± 0.04	2.30 ± 0.02	16.43 ± 0.47	5.75 ± 0.25
Camel Meat	77.67 ± 0.58	1.17 ± 0.29					18.02 ± 0.22	
Milk	84.93 ±	0.67 ±	1.06 ±	5.19 ±	16.40 ±	6.80 ± 0.02	18.51 ±	4.76

	0.31	0.08	0.01	0.04	0.01		0.46	± 0.02
Cow Meat	73.67 ± 0.58	1.67 ± 0.29					17.35 ± 0.18	
Milk	80.80 ± 0.40	1.07 ± 0.12	1.02 ± 0.01	4.48 ± 0.01	12.26 ± 0.25	3.30 ± 0.02	17.51 ± 0.40	6.02 ± 0.25
Goat Meat	79.67 ± 0.29	1.83 ± 0.29					16.30 ± 0.26	
Milk	91.33 ± 0.31	0.33 ± 0.11	0.91 ± 0.01	3.41 ± 0.01	6.40 ± 0.01	4.20 ± 0.02	18.54 ± 0.19	4.05 ± 0.02
Sheep Meat	69.67 ± 0.76	2.33 ± 0.29					18.98 ± 0.13	

Table2. *Mineral content of meat and milk samples (mg/kg)*

Meat Sample	Ca	Mg	Na	K	P
Camel meat	0.62 ± 0.06	0.22 ± 0.08	130.80±3.81	2016.67±76.38	7.04±01
Camel mil k	0.51 ± 0.03	0.95 ± 0.05	110.00±2.50	1133.33±28.87	6.20±0.04
Cow meat	0.90 ± 0.05	1.03 ± 0.08	124.16±3.81	1433.33±28.87	6.86±0.02
Cow milk	0.68 ± 0.08	1.38 ± 0.16	99.17±2.89	533.33±28.87	5.30±0.03
Goat meat	0.88 ± 0.03	0.17 ± 0.08	114.17±1.44	1350.00±50.00	6.40±0.02
Goat milk	0.82 ± 0.07	1.77 ± 0.13	115.83±3.82	1333.33±76.38	4.83±0.08
Sheep meat	0.55 ± 0.05	0.30 ± 0.00	118.33±1.44	1616.67±76.38	6.94±0.03
Sheep milk	0.55 ± 0.06	1.27 ± 0.08	80.83±3.82	883.33±76.38	4.03±0.08
RDA(mg/day)	1200	350	500	2000	800

RDA = Recommended Dietary Allowance for Adults

Source: NRC, 1989.

Table3. *Heavy metal content (mg/kg)*

Sample	Co	Cr	Mn	Pb	Ni	Hg	Ba	Cd	Cu	Zn	Fe
1. Camel Meat	ND	ND	0.15	ND	ND	ND	ND	0.349	0.450	0.206	0.868
2. Camel Milk	ND	0.191	0.06	ND	ND	ND	ND	0.105	0.161	0.416	0.146
3. Goat Meat	ND	ND	0.04	ND	ND	ND	ND	0.084	0.364	0.164	0.416
4. Goat milk	ND	ND	0.04	ND	ND	ND	ND	0.420	0.126	0.321	0.216
5. Sheep Meat	ND	ND	0.05	ND	ND	ND	ND	0.224	0.343	0.146	0.326
6. Sheep milk	ND	ND	0.14	ND	ND	ND	ND	0.103	0.721	0.565	0.105
7. Cow Meat	ND	ND	0.06	ND	ND	ND	ND	0.203	0.216	0.158	0.121
8. Cow milk	ND	ND	0.02	ND	ND	ND	ND	0.000	0.143	0.432	0.211
9. RDA (mg/day)			2 – 5	0.02				0.5	1.5 – 3	12 – 15	10 – 15

RDA = Recommended Dietary Allowance for Adults

Source: NRC, 1989.

6. DISCUSSION

Moisture content: From Table 1, the result showed that the sheep milk has the highest moisture content (91.33±0.31%) followed by the camels, cows and finally the goat meat (80.80±0.40%) has the least value. The reverse is the case when it comes to moisture content of the meat. The

sheep meat has the lowest moisture content (69.67%±0.76) followed by the cow, the camel and goat 79.67±0.29 which is a bit lower than value obtainable from free encyclopedia (84.00±0.20%). This could be attributed to the hot whether prevalent at the time of sampling. Moisture content is a valuable parameter in determining the extent of microbial growth.

Ash content: Amongst the milk of animals sampled, the goat milk 1.07±0.12% has the highest ash content followed by the cow then the camel and least of all the sheep. Interestingly, the goat milk that has the highest ash content also has the lowest moisture content of 80.80±0.40% content, the sheep 2.33%±0.29 has the highest ash content followed by the goat, the cow and the least was the camel's meat as content 1.17±0.29%. It is also worthy of note that the sheep meat that has the highest Ash content also has the lowest moisture content of 69.67±0.76%.

Calcium and magnesium content: Through determined differently, the Ca and Mg content follow a similar pattern and both being highest in the goat milk and closely followed by those of cow, sheep and camel. The goat milk having the highest Ca/Mg content could be attributed to the fact that the goat sampled is reared in an urban area where natural pasture and artificial feeds that has been packed with minerals are being feed the goat. The calcium and magnesium content of both milk and meat of the different samples are low when compared with the recommended dosage obtainable from NRC Standard (1989) of 1200mg/day and 350mg/day respectively.

Potassium K: From the table of result, it shows that it followed the same pattern as that of sodium where camel meat has the highest potassium content (2016±76.38mg/kg) while the goat meat as the least (1350.100±50.00 mg/kg). The goat milk has the highest sodium content (1333.33±76.58 mg/kg) while the cow milk has the least (533.33±28.87mg/kg). Generally, only the camel meat has a little above the recommended daily intake of 2000mg/day while the rest samples are below the recommended daily intake (NRC, 1989).

Sodium Na: Camel meat has the highest sodium content of 130.8±3.8mg/kg while the goat meat has the least 114.17mg/kg so also camel milk has the highest value for sodium content (110.00±2.50mg/kg) while the sheep milk has the least 80.83±3.82mg/kg. Both values of sodium content in meat and milk samples of the different animals are below the recommended daily intake of sodium (500mg) day (NRC, 1989).

Phosphorous P: From the table of result, it shows that camel meat has the highest phosphorus value 7.04±0.041mg/kg while the goat meat has the least value of 6.395±6.021mg/kg. So also amongst the milk samples, camel milk has the highest value of 6.197±0.035mg/kg while the sheep milk has the least value 4.033±0.076mg/kg. They are all far below the recommended daily allowance of 800mg/day NRC 1989.

Specific gravity: The camel milk have the highest specific gravity of 1.12±0.01 followed by that of the cow milk1.06±0.01), the goat (1.02±0.01) and least of all, the sheep (0.91±0.01). This agrees with most literature and very close to that of Morrison (1998) who recorded a specific gravity of 1.012 for goat meat.

Lactose: From the Table 3.5, the camel's milk has the highest lactose content 6.27±0.06%, which is a bit higher than 5.26%, is obtained by Brody (1999) followed by those of the cow and the goat while the sheep has the least. Lactose is responsible for the sweetness of the milk.

Total solid: From the Table 3.6, sheep milk has the highest total solids of 16.40±0.01% very close to 16.5% obtained by McGee (2004) from goat milk. It is closely followed by that of the cow, then that of the goat and the least is that of the camel (6.4).

Fats: The cow milk has the highest fat followed by the sheep, then the goat and the camel has the least. This could be attributed to the fact that the cow is mostly the animal usually fed from area of grazing land and even with different feeds than the camel because of its demand and translates into excess stored fat from the excess food.

Acidity: From the Table 3.9, the goat milk has the highest acidity followed by the camel, the cow and the least of all the sheep milk. Acidity is a critical parameter with respect to both food safety and both process and quality control of fermented foods such as cheese.

Iron Fe: From the meat samples, camel has the highest value (0.868mg/kg) with the cow having the lowest value of (0.121mg/kg) iron content. In the milk sample, the goat milk has the highest

value (0.216mg/kg) while the sheep milk has the least value (0.105mg/kg). Their values are yet below the recommended daily intake of 10 – 15mg/day (NRC 1989).

Co/Pb/Ni/Hg/Ba: These metals were not detected in both milk and meat of the animals understudy. This could mean that there is low pollution with respect to these metals in the area of study.

Chromium Cr: Chromium was not detected in any of the meat sample. It was also not detected in the milk samples except for the camel milk (0.191mg/kg) which is higher than what was reported in fresh milk of cow by Aniello *et al.,* (2005). Presence of chromium in the milk of camel and its absence in all other samples especially the camel's meat may be ascribed to the fact that chromium is preferentially bound to milk components such as caseins (Aniello *et al.*, 2005). EU regulations have not yet fixed limits for chromium in milk or dairy products. However the mean chromium value obtained in the camels milk was lower than the limit established by the Italian National Residue Plan for oxine spleen tissue which is considered as a bio accumulator of this metal.

Copper Cu: From Table 3, it shows that camel meat (0.450mg/kg) has the highest value followed by the goats, sheep and the cow meat has the least value (0.216mg/kg). It is higher than that reported by Hamouda (2002) while lower findings were reported by Garcia *et al.* (1999). In the milk samples, the cow has the least value (0.143mg/kg) while the sheep milk has the highest value (0.721mg/kg). The values of copper content obtained from both milk and meat are below the recommended dietary value of 1.5-3mg/day (NRC, 1989)

Zinc Zn: From the table, camel meat has the highest zinc value (0.206mg/kg) followed by goat, cow and the least is sheep meat (0.146mg/kg). That of the cow meat (0.158mg/kg) is far below the value obtained in cow meat by Mazzotta *et al.* (1993) and Garcia *et al*. (1999). From the milk samples, sheep milk has the highest zinc value while goat milk has the least. Both are below the recommended dietary value (NRC 1989).

7. CONCLUSION

Indeed the importance of milk and meat of animals as essential sources of protein cannot be disputed. Similarly, the dangers and effect of heavy metal poisoning cannot be ignored. From the result, it shows that the sample; meat and milk of camel, cow, goat and sheep may be safe for consumption because most of those highly toxic metals like mercury, lead, nickel and cobalt were not detected in the samples and also some of the essential minerals such as calcium, phosphorus, potassium, sodium, zinc, copper, iron and chromium did not exceed their permissible limit (NRC Standards, 1989) except for camel meat which is a little above the permissible limit for potassium content (800mg/kg). However, deficiency could also not be good as some of these essential minerals needed for normal physiological body processes are below the limit recommended for daily intake.

RECOMMENDATIONS

Based on the result of the analyses conducted, the following recommendations are made that further work should be done to determine and compare the heavy metal content of:

I. Animals reared here (indigenous) and those brought in from other neighbouring countries.
II. Meat and milk of animals from different rearing areas e.g. industrial, rural, heavy traffic areas, etc.
III. Fresh meat and milk at the point of collection (abattoir) and after exposure (at selling points).
IV. Different animals based on their feeding pattern i.e. those fed with natural pasture and those fed with processed feeds.

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