



RESEARCH PAPER

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Evaluation of the physico-chemical quality of the cheese-based of cow's milk sold in the markets of porto-novo (Benin)

Hugues Assongba¹, Fadéby Modeste Gouissi^{*2}, Guy Marius Assogba³,
Sahidou Salifou⁴

¹Central Laboratory of Control of Food Safety Regulators, Cotonou, Bénin

²Faculty of Agronomy (FA), University of Parakou (UP), Parakou, Benin

³Regional Center for Rural Development (CARDER Ouémé Plateau), Porto-Novo, Bénin

⁴Department of Health and Animal Production, Polytechnic School of Abomey-Calavi (EPAC),
University of Abomey-Calavi (UAC), Cotonou, Benin

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Abstract

The present study focuses on the physico-chemical analysis of cheeses that are selling in markets of Porto Novo city. As one of main city, Porto-Novo is facing the challenge of air pollution which is provided from the informal gasoline's selling, motorbikes taxi activities that produce huge amount of exhaust gas as well as the mismanagement of domestic wastes. Cheese is cow's milk by product which is most consume in polluted environment. For the purpose of public health security, the toxicological and physico-chemical surveys on cheese were conducted in four markets of this city and enabled us to appreciate the pollution level of cheese. We have to determine the moisture content; pH and dosage of the lead and cadmium. The dosage of metals, the lead and cadmium contents were measured through analysis of spectrophotometric molecular absorption. The obtained results show that the high concentration of toxic metals varies from 0.83 mg/kg to 0.95 mg/kg for lead and varies between 0.18 mg/kg and 0.25 mg/kg for cadmium. Besides, the average lead content in these cheeses from the market of Ahouangbo is 22.5 time high than accepted standard set by international organizations such as the WHO, the codex alimentarius, while the one in Gbégo market is 40.5 time. The results raise the issue of public health and illustrate the consequences of anthropic actions likely to affect the quality of foodstuffs exposed to the open air. And since cheese must be delivered in a safe and appropriate condition to consumers, suggestions have been formulated in the present document through a good practice of milk collection, cheese production and storage, and its sale. We estimate that the implementation of the proposals in an efficient way will help reduce the prevalence of contaminants in foodstuffs in general and in cheeses in particular.

* **Corresponding Author:** Gouissi F. Modeste ✉ gouissi@yahoo.fr

Introduction

Benin as most of African countries has an economy based principally on agricultural activities among which the breeding occupies a special place. It contributes for approximately 7.5% of the gross domestic product (INSAE, 2003). Cheese is one of by products of the breeding, which is obtained from the coagulation of the milk and it is particularly rich in protein and fat (Egounléty *et al.*, 1994). Due to its low content in lactose, it recommended to the people suffering from the intolerance in the lactose (Kora, 2005). It is consumed by numerous people in the world for their food (Kora, 2005). The high demand of cheese consumption is observed in Benin main cities. His demand is still increasing, and it is a business opportunity for sellers who go far to different rural areas in the north of Benin to collect these cheeses that are packaged and sent towards cities (Kora, 2005). During the rain period, cows produce high quantity of milk as they are fed of natural vegetation; consequently the markets of Benin's big cities are flooded of divers' qualities of milk by products, specially cheeses. These cities are considered as unsafe environment due to their rate of air pollution (Douay et Sterckeman, 2002; Miquel *et al.*, 2001). According to Mench *et al* in 1997, the big cities are facing the issue of environmental problems. Despite of the number of symposiums and seminars organized with the supports of government and International Organization in order to define the strategies to cut down the level of air pollution in the main cities, the pollution problem persist (Burkina, 2005; Edoth *et al.*, 2005; Loué, 1993).

In the capital city of Porto-Novo, the environmental problem occurs in term of air pollution, water pollution and ground pollution. These pollutions are linked to the economic activities of the low income population which are informal selling gasoline that is provided from smuggle from Nigeria, motorbikes taxi which yield huge amount of exhaust gas. Indeed, problems of management of the waste (biomedical and chemical waste) of all kinds constitute a concern today. Thus, it is important to be interested in the quality of fresh products which are sold in such environment.

That is the raison the research particularly interested in the sanitary quality of cheeses of cow's milk sold in such an environment.

Materials and methods

Study area

The research was carried out in the capital city of Porto Novo located in the south east of Benin Republic. The cheeses' samples were collected from four selected markets of Porto Novo city which are Ouando, Gbégo, Ahouangbo and Grand marché.

Cheese's sampling

The cheeses were sampled randomly in each of the selected market from different sellers. Composite samples were made with three replicates from each cheese's seller and a total of 22 samples of cheese were collected (Table 1). The samples were put in zip bags that were stored in carried refrigerator and took to the Laboratory for diverse analysis.

Methods of analysis

These samples have undergone different analysis mainly: determination of the moisture content; pH and dosage of the lead and cadmium. The dosage of metals, the lead and cadmium contents were measured through analysis of spectrophotometric molecular absorption in the Laboratory of Quality Control of Water and Food (LCQEA) of the Direction of the Hygiene and the Basic Purification (DHAB) in Benin.

Determination of the moisture content

The cheeses samples' moisture content was determined by the method of steam according to the standard ISO 712-1979 at $103\pm 2^{\circ}\text{C}$ until obtaining of constant weight. The steam room which was used is the universal steam room of the series of the types SNB/SFB of internal capacity of 108L. A quantity of every sample was weighed in a petridish which was before hand dried and cooled down in the desiccators. The box containing the sample was introduced into the steam room in the temperature of $103\pm 2^{\circ}\text{C}$ for 4 hours. The box was removed and cooled down during 15 minutes. After weighing it was reintroduced in the steam room during 15 minutes. This was repeated until obtain of constant weight.

Determination of the pH

The pH of the cheeses' samples was measured with pH-meter HANNA of type HI 221. 10g of each samples cheese was taken and crushed in porcelain mortar and 100 ml of distilled water is added to the grounded cheese. The homogeny mixture is used to determine the pH.

Dosage of the lead and cadmium

The quantification of these metallic traces was obtained by the HACH method of spectrophotometric molecular absorption for the Laboratory of DHAB.

The samples of cheeses were mineralized in order to enable the heavy metal extraction. First of all, a piece of each sample of cheese was taken and ground in porcelain mortar. 0.5 g of fine samples ground cheese were collected with a sieve of 0.2 mm and put down in a thermo resistant phial for desiccation. Besides, 4 ml of concentrated sulphuric acid (H_2SO_4) is added to the sieved cheese and put to the temperature of 440°C until complete incineration.

The ash obtained was mixture with 10 ml of hydrogen peroxide (H_2O_2) in 30% in order to clear up the steamed product. An additional, 10 ml of distilled water is put on the dissolved. It is on this mineralized solution that was used for the dosage of the lead and the cadmium according to the HACH method.

The solution of dithizone was used to extract lead and cadmium from the mineralized solution. The dithizone constitutes a stable complex with the lead and cadmium which are then extracted by the chloroform.

Statistical analysis

The average and standard deviation of data were computed with Microsoft Excel 2010 software. For the multiple comparison of average, the test of student p ($T>t$) = 0.05 was used through the statistical package of Social Sciences (SPSS) Version 17.

Results and discussion

Physico-chemical analysis results of cheeses collected in the four markets of Porto novo are presented in the following tables.

Table 1. Number of cheese's samples collected.

Sampled location	Number of samples
Ouando Market	08
Gbégo Market	03
Ahouangbo Market	05
Grand marché	06

Market of Ouando

The results obtained with the samples of cheeses are recorded in the Table 2.

From the results, it appears that the lead content is widely above the cadmium content; it is 3 to 6 time great than the content of cadmium.

The lowest lead concentration found in the cheeses is 0.51 mg/kg against 0.09 mg/kg for the cadmium, while the highest value, it is 0.95 mg/kg for the lead and 0.25 mg/kg for the cadmium.

Table 2. Results of Physico-chemical analysis of cheeses of Ouando.

Code of the cheeses	Moisture content (%)	pH	Lead content (mg / kg)	Content in cadmium (mg / kg)
F1	52.75	6.51	0.95	0.20
F2	52.84	6.50	0.75	0.14
F3	49.68	6.40	0.70	0.25
F4	49.88	6.45	0.60	0.20
F5	63.25	6.47	0.66	0.09
F6	63.58	6.40	0.51	0.11
F7	54.98	6.30	0.63	0.13
F8	54.72	6.47	0.77	0.14
Average	55.21±5.42	6.43±0.06	0.69±0.13	0.15±0.05

In this market, the average values of lead and cadmium are respectively 0.69 mg/kg and 0.15 mg/kg, these values are clearly above the national and international standard which is 0.02 mg/kg for the lead. The results show that the lead average content of

cheeses of this market is 34.5 times the accepted standard of the European Union regulations, the codex alimentarius and Bénin (Arrêté N°0362/MAEP/D-CAB/SGM/DRH/DP/SA of 30th October 2007).

Table 3. Physico- chemical results of the suspensions obtained in Ouando market.

Code of the suspensions	Lead content (mg / kg)	Content in cadmium (mg/kg)
S1	3	0.56
S2	2	0.40
S3	1.80	0.50
S4	2	0.44
Average	2.33±0.57	0.47±0.07

It shows that these cheeses are highly contaminated by the lead. The values of the suspensions obtained in the same market are 3 mg/kg for the lead and 0.56 mg/kg for the cadmium, this confirm the contamination of the cheeses by heavy metals in the Ouando market.

This lead's value (3 mg/kg) obtained in this market explains the impacts of anthropogenic activities in particular exhaust gas in the air which is generated by numerous taxi moto bikes and poor protection condition of cheese selling. Around the market, there is adulterated gasoline trade that is bought by most of people in their engine.

Table 4. Results of the physico-chemical analysis of cheeses of Gbègo.

Code of the cheeses	Moisture content (%)	pH	Lead content (mg / kg)	Content in cadmium (mg / kg)
F9	50.00	6.34	0.80	0.15
F10	50.28	6.51	0.80	0.18
F11	51.34	6.29	0.83	0.15
Average	50.54±0.70	6.38±0.11	0.81±0.01	0.16±0.01

Table 5. Results of physico-chemical analysis of cheeses of Ahouangbo.

Code of the cheeses	Moisture content (%)	pH	Lead content (mg / kg)	Content in cadmium (mg / kg)
F12	59.82	6.44	0.16	0.14
F13	59.25	6.30	0.73	0.15
F14	53.52	6.54	0.65	0.14
F15	53.38	6.37	0.61	0.14
F16	53.32	6.39	0.14	0.15
Average	55.85±3.36	6.40±0.09	0.45±0.28	0.14±0.005

Indeed, some reports of our region experts (Burkina, 2005) indicate that the lead contained in the gasoline is used as anti-knock and is rejected in exhaust fumes. The exhaust fumes would be one of the lead contamination sources found in these samples of cheeses.

This result is confirmed by the study of Kora in 2005 in Cotonou. Other authors (Edorh *et al.*, 2010) showed that the drink water, the grounds and the sediments of cotton region of Gogounou, Kandi and Banikoara are contaminated by the lead.

These results confirm that the lead can be found in the cheeses because the water is used to prepare the cheeses. Also, any cheese from these zones can be subjected to a risk of lead contamination. It is showed by Table 3.

Market of Gbégo

The results obtained on the samples of cheeses are recorded in the table 4.

These results reveal that the lead content is widely above the values of the cadmium. The lowest lead concentration is 0.8 mg/kg against 0.15 mg/kg for the cadmium.

As the highest value, it is 0.83 mg/kg for the lead and 0.18 mg/kg for the cadmium.

The average values of the lead and cadmium respectively 0.81 mg/kg and 0.16 mg/kg obtained in this market are also above the international standard.

The lead average content of cheeses of this market is about 40.5 times the standard of the consumers' protection institutions. It means that these cheeses are also contaminated by the lead. The values of the suspensions obtained in this market are 2 mg/kg for the lead and 0.40 mg/kg for the cadmium confirm that these cheeses are contaminated with heavy metals in this market.

Table 6. Results of the physico-chemical analysis of cheeses of Grand marché.

Code of the cheeses	Moisture content (%)	pH	Lead content (mg / kg)	Content in cadmium mg/kg
F17	55.49	6.29	0.89	0.15
F18	54.66	6.47	0.54	0.22
F19	55.22	6.51	0.58	0.13
F20	53.11	6.37	0.78	0.15
F21	56.27	6.40	0.87	0.21
F22	59.31	6.42	0.85	0.15
Average	55.67±2.06	6.41±0.07	0.75±0.15	0.16±0.03

Opposite to others markets, Gbégo is specialized in the selling of manufacture items and the house electrical products which produce least contaminated waste. The great concentration of heavy metals in cheeses from this market may be the consequence of the use of contaminated milk to make the cheese.

Market of Ahouangbo

The table 5 shows that the lead content in various cheeses of this market is higher than some of cadmium. Also the average value of the lead (0.45 mg/kg) is 22.5 times worth that authorized by existing standard. The analysis of the suspensions from this market gives a 1.80 mg/kg average value for the lead and 0.50 mg/kg for the cadmium. These results confirm that this market is polluted by heavy metals what would have caused a certain chemical contamination of cheeses.

The same conclusions made on the previous markets are still valid in this market. It is to notice that the concentrations found in this market are lower than those of the first two markets.

Grand marché

The results of the samples of cheeses of this market show us in table 6 that the lead content is widely above the values of the cadmium content as in the other markets. The lowest lead concentration is 0.54 mg/kg against 0.13 mg/kg for the cadmium concentration. As for the highest value, it is 0.89 mg/kg for the lead and 0.22 mg/kg for the cadmium. The average values of the lead and cadmium respectively 0.75 mg/kg and 0.16 mg/kg obtained in this market are also above the acceptability standards. The lead average content of cheeses of this market is about 37.5 times the standard of the consumers protection institutions. It means that these cheeses are also contaminated by the lead.

The suspension values obtained in this market 2 mg/kg for the lead and 0.44 mg/kg for the cadmium confirm that these cheeses are contaminated by heavy metals. We can now assert that the big market like other markets is polluted by heavy metals.

Statistical analysis of the data of all the markets

The statistical results of the toxicological and physiochemical analysis of all the markets are presented in the table 7.

This study allowed to notice that the environment of Porto-Novo is contaminated by toxic metals (lead and cadmium) found in the various markets (Ouando, Ahouangbo, Gbègo and Grand marché). These results allowed us to measure the pollution level of our capital city. Indeed, the various heavy metal contents found in cheeses of these markets exceed the international organization standards such as the European Union, the FAO and the WHO. There is thus a threat not only for the health of the consumer populations of cheeses but also other foodstuffs sold in the same conditions.

Table 7. Moderate physico-chemical parameters of cheeses.

Collection site	Moisture content (%)	pH	Lead content (mg / kg)	Content in cadmium (mg/kg)
Ouando	54.21±4.98a	6.43±0.07a	0.72±0.13ab	0.17±0.06a
Ahouangbo	55.89±3.33a	6.44±0.11a	0.46±0.28a	0.14±0.00a
Grand marché	54.67±1.25a	6.40±0.08a	0.75±0.15ab	0.17±0.04a
Gbègo	50.54±0.70a	6.38±0.11a	0.81±0.2b	0.16±0.02a

a,b: the values so much even letters in the same column are not significantly different ($P > 0.05$).

We showed previously that the scientific studies confirm more and more that the cheeses of cow's milk is an excellent food product. But these heavy metals, in particular the lead and cadmium which we found constitute a real threat for the human health and for the environment.

These studied substances can cause toxic effects to the consumers in short-term, golden-term and long-term.

Even if these preliminary results concern only a small zone of our environment, they are really worrying and owe to call out the government and all the consumers of this foodstuff so appreciated by number of people. But Bénin unfortunately has not enriched statistics which allow a better appreciation of the national situation, it is important to popularize the study on several zones of our country and to realize a follow-up during several years to proceed to a comparative analysis allowing us to appreciate well this pollution. This study opens the way to a more advanced research about the quality of cheeses sold in markets and along the streets of our country.

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