

Original Research Article

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## Microbiological Characteristics of Foods of Children Aged 0 to 24 Months with Moderate Acute Malnutrition (MAM) in the Department of Mayahi in Niger

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### ABSTRACT

Each day, all over the world, people are getting sick because of the unhealthy foods they eat. Associated with malnutrition, diseases caused by unhealthy food cause unbearable damage and are the leading cause of child mortality in countries where hygiene is deficient. The aim of our study was to assess hygiene practices and analyse the microbiological quality of food for children with moderate acute malnutrition (MAM) in the department of Mayahi. For this purpose, a questionnaire on socio-economic characteristics and environmental hygiene was administered to 50 mother /childpairs, then 50 food samples were taken for analysis in the laboratory. It emerges from the study, the environmental health of the respondent is not good in 52% and most households do not have latrine in 58% case and a source of drinking water in 70% case. The microbiological analysis of foods has shown that 66% was compliant (satisfactory), 6% Acceptable and 28% nonconforming (unsatisfactory). Analysis of these samples showed a high loading of microorganisms with an average of  $4.5 \times 10^6$  UFC / and the presence of pathogenic bacteria in some foods which represents a risk or danger to the consumer. The improvement of the quality of these foods can be done by appropriate hygiene measures. Based on the result several measures can help us to improve the conditions of hygiene and avoid contamination of food, namely literacy and awareness on environmental health and sanitation.

#### Keywords

Moderate acute malnutrition, Food, Quality, Microbiology, Hygiene, Niger

#### Article Info

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### Introduction

Many people around the world fall ill because of the contaminated food they consume.

WHO (World Health Organization) estimates that 1.8 million people die each year from

diarrheal diseases, and most of these cases can be attributed to contaminated food or water (WHO, 2007). Pathogens that have been identified as the most common causes of diarrheal diseases are bacteria like *E. coli*, *Shigella spp.*, *Salmonella spp.*, *Vibrio cholera* and *Campylobacter jejuni*, protozoa such as

*Giardia lamblia*, *Entamoeba histolytica*, *Cryptosporidium spp.*, and also enteric viruses such as rotaviruses.

In countries with low levels of hygiene, bacterial diarrhea is responsible for more than four million deaths each year.

Their transmission is favored by the lack of collective equipment necessary for the disposal of wastewater and the distribution of drinking water, but the exchange of enteric bacteria results mainly from direct human contact and frequent pollution drinking water (Huttly, 1997).

The environment is the cause of nearly 21% of the world's diseases (Adjoutah *et al.*, 2016). The deleterious influences of this environment on our organism put it in front of an integral defense. Moreover, it is fundamental to understand that the content of our digestive tract is still part of this ambient environment and it is at this level that we are the most fragile and least protected (Seignalet, 2004).

The tribute paid in human suffering is therefore enormous, especially for the most vulnerable groups (infants and young children, pregnant women, the elderly, the sick, etc.).

Malnutrition-related diarrheal diseases caused by unhealthy diets cause unbearable damage and are the leading cause of child mortality in countries with poor sanitation. The prevalence is rising sharply due to the many interacting factors, mainly poorly controlled hygiene at different stages of production and distribution, and at the consumer level (WHO, 2017).

Food hygiene is regularly invoked and often questioned in the context of food poisoning, and the rules of hygiene of course concern producers, distributors but also every individual who consumes food.

These infectious diseases act indirectly in various ways on nutritional status. Loss of appetite and intolerance to food affect the metabolism.

Under nutrition and repeated intestinal infections promote the occurrence of intestinal enteropathy, resulting in increased intestinal permeability and low-grade intestinal inflammation. These mechanisms are involved in stunting and delayed cognitive development, due to disruption of the gut-brain axis (Emanuel, 2017).

First cause of infant mortality and morbidity in Niger, malnutrition is not caused exclusively by food insecurity. It can result from a multiplicity of other causes including disease, unsanitary environment, polluted water consumption or parental neglect.

Food habits, low health coverage, the limited availability of drinking water and medicines are all factors that affect nutrition and health. They can be considered as underlying causes of the disease and the inadequacy of the diet. When a child is malnourished, his or her immune system is affected. Common diseases such as malaria or diarrheic can lead to complications and the risk of death is very high (IFRC, 2011).

The study was made in the Maradi region more precisely in the department of Mayahi. The choice of this region is justified by a global malnutrition rate higher than the national average (INS, 2012). However, very few or no studies have examined the quality and sources of food contamination of children with moderate acute malnutrition in this region.

The aim of our study was to assess hygiene practices and analyse the microbiological quality of food for children with MAM in the Department of Mayahi

## Materials and Methods

### Materials

The material used for this study was a questionnaire with closed questions and open questions. It consists of a section on the characteristics of the respondents, another on environmental hygiene and a form for recording the information of the food samples. For the collection of food we used a cooler, ice for food preservation, a sterile bag, sterile gloves and a trowel (Table 1).

### Methods

#### Study area and target population

The study was made in Niger in the Maradi region in 5 communes of the department of Mayahi namely: Mayahi, sharkin shrugged Kanen Bakache, Iswane and Tchake (Figure 1). The target population was mothers of children with MAM who came to visit infants in integrated health centers.

#### Methodology of the study

This is a cross-sectional descriptive study among mothers of children aged 6 to 24 months attending Integrated Health Centers (IHC) to receive an outpatient treatment for moderate acute malnutrition. A questionnaire was used to identify the socio-economic characteristics of mother / child couples. Then 50 samples of food product were taken from the mothers. The samples of dishes were collected during the day, put in sterile food bags, placed in a cooler containing ice and sent to the National Laboratory of Public Health and Expertise (LANSPEX) for analysis. During sampling, special attention was given to the origin of food, the existence of latrines, the proximity of waste water channels, stray animals, unpleasant invasive odors, insects (flies), packaging, hygiene of utensils and hygienic practices of mothers

(personal hygiene, handling and preservation of food).

### Sampling

50 mother / child pairs were randomly selected from the integrated health centers (IHCs) of the 5 municipalities of Mayahi.

### Enumeration of food microorganisms

The number of microorganisms in different foods was determined according to the method described by the National Coordinating Center for Studies and Research on Nutrition and Food (CNERNA, 1996). As soon as the sample arrives in the laboratory, quantities are taken from each unit and diluted in a bottle containing peptone water. The mixture is put in a sterile bag and introduced into the stomacher which grinds for 2 min. After revivification of the mother solution, the initial dilution is carried out by taking 1 ml of the stock solution which is taken and put into 9 ml of peptone water, dilution  $10^{-1}$  is carried out. To carry out the  $10^{-2}$  dilution, 1 ml of the dilution is added in 9 ml of peptone water so on to carry out the  $10^{-3}$  dilutions.

Total mesophilic aerobic flora (TMAF) was analysed by plating 0, 1 mL dilutions  $10^{-1}$ ,  $10^{-2}$  and 3 samples in Petri dishes containing the agar PCA previously melted and cooled is cast. After homogenization and solidification, a second agar layer is cast. The dish is incubated at 30 ° C. for 72 hours. The whitish colonies grown at depth are enumerated by counting on the basis of colony-forming units (CNERNA, 1996).

*E. coli* research is carried out at a dilution of  $10^{-1}$ , 1 ml of dilution is introduced into a Petri dish to which the VRBL agar is added. After solidification, a second layer is poured on the surface as before. Incubation is at 44 ° C for 24 to 48 hours. Only well red colonies greater than 0.5 mm in diameter and having

grown at depth are counted. BLBVB medium was used to confirm the presence of *E. coli* (CNERNA, 1996).

*Salmonella* research is done in several stages: The pre-enrichment, enrichment, the isolation and identification. For confirmation e tests, we used the enterotubes (Middle Rapaport) (CNERNA, 1996).

### **Microbiological criteria selected for the study**

According to JOUVE, a microbiological criterion is "a set of qualitative and quantitative elements defining the essential microbiological characteristics expected from a given product and that can be achieved by appropriate interventions".

In the absence of local standards, we referred to French microbiological criteria for assessing the microbiological quality of food.

In the case of ready meals, these criteria are as follows:

Aerobic total mesophilic flora at 30 ° C (FAMT): <3.0.10<sup>5</sup> CFU / g  
*Salmonella* (Sal): absent / 25g  
*E. coli*: <10 / g  
(CFU/g: Unit Forming Colonies per gram)

### **Data processing and analysis**

Quiz entry and data analysis were done with SPSS 20, Word and Excel 2010.

### **Results and Discussion**

#### **Characteristics of the respondents**

All respondents were mostly young female. In fact, 38% were under 18, 50 % were between 18 to 25 years old and 12% were between 26 to 38 years old.

Most of the mothers were married at a rate of 86% against 14% for unmarried.

Polygamy is the type of union as encountered with a rate 66% and 34% for those living in monogamy.

The level of education is very low among respondents: 82 % of them have never been to school. Only 16 % have a primary level and 2% a college level (Table 2).

#### **Environment of the respondents**

Clay is the most used type of material with a 96% rate. In general, we found that the environment of the respondents is marked by the presence of stray animals, mainly sheep and insects like flies and sometimes ants and puddles of puddles. Given the places of preparation (in the open air, in full dust....), It is not uncommon to encounter grains of sand in certain foods.

Most households do not have a latrine (58%) and a source of drinking water (70%). In general, the environmental hygiene of the respondents ' preparation is not good (52%).

88% of respondents said that they did not wash their hands with soap before meals and out of the toilet (Table 3).

#### **Level of food contamination**

#### **Results interpretation**

The interpretation of the results is based on:

The 2-class plan for unencrypted standards (for *Salmonella* research in 25 g). If *Salmonella* are absent in 25 g, the result is SATISFACTORY. In the opposite case, the

result is CORROMPU, that is to say that the food is unfit for consumption;

The 3-class plan for the norms (Search for *E. coli* and FMAT), and is carried out as follows:

Below the norm and up to 3 times the standard the result is SATISFACTORY, from 3 to 10 times the norm it is ACCEPTABLE, higher than 10 times the standard NOT SATISFIED SANT (CNERNA, 1996).

To consider that a sample is satisfactory, all the results must be satisfactory. Unsatisfactory mention of a sample is possible only if at least one of the results of the sample is unsatisfactory or the sum of the results is satisfactory with 3 acceptable results. For the acceptable mention at least one result must be acceptable and the sum of the other satisfactory.

### **Overall results**

The results are extended over the period from September to December 2017, four (4) month. A total of fifty (50) samples were analysed, 33 were found to conform (satisfactory), 3 acceptable and 14 non-compliant (not satisfactory). The largest microbial load is found in the sample «couscous of Mais + Sauce» and the smallest load in millet porridge. These results are shown in Figure 2 and detail in table 4.

### **Variation of the contamination level according to the germs**

#### **Total aerobic mesophilic flora (TAMF) at 30 ° C (Fig. 3)**

FMAT was present in all samples with a mean contamination of  $21.18.10^5$  UFC/g. 14 samples were unsatisfactory, 3 were acceptable and 33 were satisfactory.

### **Result for *E. coli* research**

Meal analysis revealed the absence of thermo-tolerant coliforms (*E. coli*) except for 3 samples where nonconformity was recorded. The figure 4 illustrates these results:

### **Result of *Salmonella* search**

In all samples there is no *Salmonella* in the 25 grams except in 2 cases illustrated in the figure 5.

The objectives of our study were to devalue hygienic practices and bacteriological quality of food for children with MAM.

### **Characteristics of the respondents**

Our study reveals that all the respondents were mostly young women (88 %). This is explained by the fact that in Niger, s' after children is an area reserved for women. The young character of our respondents is due to a high early marriage rate. According to UNICEF, Niger has the highest rate of early marriage in the world. One in three girls is married before the age of 15 years and 75% of women 20 at 24 years are married before the age of 18 years old (UNICEF, 2012).

88% of our respondents were married and polygamy is the most common type of union with a rate of 66%. This results are similar to those found by ADAMOU in 2018 who found that 98.3% of women were married and 64.7% were polygamous.

Level of instruction is very low with a rate of 2% for the college level and 16% for the primary level. Sangaré in Mali found that 82.8% of mothers have no level of education (Sangare, 2008). This low level of education is said to be at the origin of the nutritional status of the children.

**Table.1** Nature and number of samples

Sample	Nature	Number
<b>Pate + Okra Sauce</b>	Solid	1
<b>Macaroni</b>	Solid	1
<b>Rice + Cowpea</b>	Solid	4
<b>Cowpea donut</b>	Solid	7
<b>Millet Cakes</b>	Solid	1
<b>Millet porridge</b>	Liquid	15
<b>Small donuts of flour</b>	Solid	5
<b>Large donuts of flour</b>	Solid	3
<b>Rice paste</b>	Solid	1
<b>Rice + Cowpea +Macaroni</b>	Solid	2
<b>Mix of pasta</b>	Solid	1
<b>Rice Yassa</b>	Solid	2
<b>Couscous + Rice</b>	Solid	1
<b>Macaroni+ Rice</b>	Solid	1
<b>Couscous of Mais + Sauce</b>	Solid	3
<b>Couscous of Mais +Moringa</b>	Solid	1
<b>Grand Donut of Cowpea</b>	Solid	1
<b>Total</b>		<b>50</b>

**Table.2** Age, marital status, type of union, level of education of the respondents

Characteristics	Number (%)	Characteristics	Number (%)
Age		<b>Type of union</b>	
<b>-18 years</b>	19 (38.0)	Monogamy	17 (34.0)
<b>18 to 25 years</b>	25 (50.0)	Polygamy	33 (66.0)
<b>26 to 35</b>	6 (12.0)	<b>Level of education</b>	
<b>36 to 45</b>	0 (0.0)	No	41 (82.0)
Marital status		Primary	8 (16.0)
<b>married</b>	43 (86.0)	Middle School	1 (2.0)
<b>lives alone</b>	7 (14.0)		

**Table.3** Environment of the respondents

Characteristics	Number (%)	Characteristics	Number (%)
Type of House		<b>Potable water</b>	
<b>Banco</b>	48 (96)	Yes	15 (30)
<b>Definitive materials</b>	2 (4)	No	35 (70)
Presence of animals		<b>Hand washing with soap</b>	
<b>Yes</b>	39 (78)	Yes	6 (12)
<b>No</b>	11 (22)	No	44 (88)
Presence of insects		<b>Environmental hygiene</b>	
<b>Yes</b>	43 (86)	good	5 (10)
<b>No</b>	7 (14)	Acceptable	15 (30)
Latrines		Not good	30 (60)
<b>Yes</b>	21 (42)		
<b>No</b>	29 (58)		

**Table.4** Interval of microbial load of sample

Sample	Nature	Number	Interval of microbial load (CFU/g)		
			<b>TAMF</b>	<i>E. coli</i>	<i>Salmonella</i>
<b>Pate + Okra Sauce</b>	Solid	1	$4.4. 10^4$	0	0
<b>Macaroni</b>	Solid	1	$3.65. 10^6$	0	0
<b>Rice + Cowpea</b>	Solid	4	$2.6. 10^3 - 4.26. 10^7$	0	0
<b>Cowpea donut</b>	Solid	7	$2. 10^3 - 2.7.10^8$	0	$16. 10^3$
<b>Millet Cakes</b>	Solid	1	$10^4$	120	0
<b>Millet porridge</b>	Liquid	15	$10^3 - 9.22. 10^6$	80	0
<b>Small donuts of flour</b>	Solid	5	$3.28. 10^6 - 2. 10^3$	0	0
<b>Large donuts of flour</b>	Solid	3	$3. 10^3 - 3.2. 10^4$	0	0
<b>Rice paste</b>	Solid	1	$3. 10^3$	0	0
<b>Rice + Cowpea +Macaroni</b>	Solid	2	$2. 10^3 - 9. 10^3$	0	0
<b>Mix of pasta</b>	Solid	1	$9. 10^3$	0	0
<b>Rice Yassa</b>	Solid	2	$2.3. 10^4 - 4. 10^4$	0	0
<b>Couscous + Rice</b>	Solid	1	$4.3. 10^4$	0	0
<b>Macaroni+ Rice</b>	Solid	1	$3.65. 10^6$	0	0
<b>Couscous of Mais + Sauce</b>	Solid	3	$9.22. 10^6 - 5.11. 10^9$	0	40
<b>Couscous of Mais +Moringa</b>	Solid	1	$9.22. 10^6$	23	0
<b>Grand Donut of Cowpea</b>	Solid	1	$9.2. 10^5$	0	0
<b>Total</b>		<b>50</b>			

Fig.1 Location map of the study area

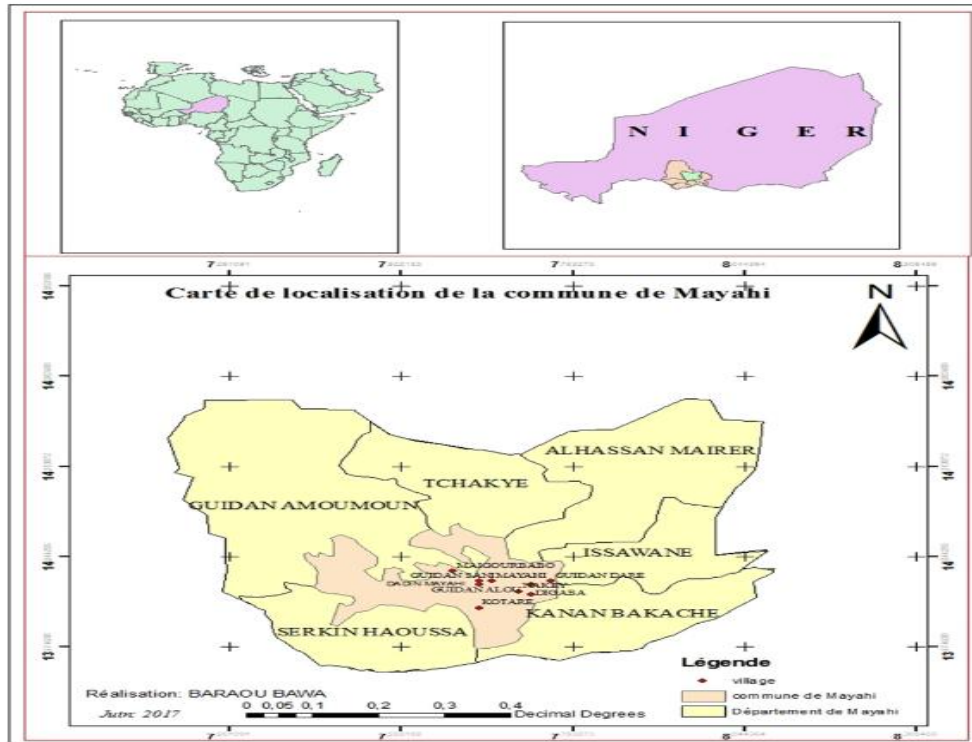
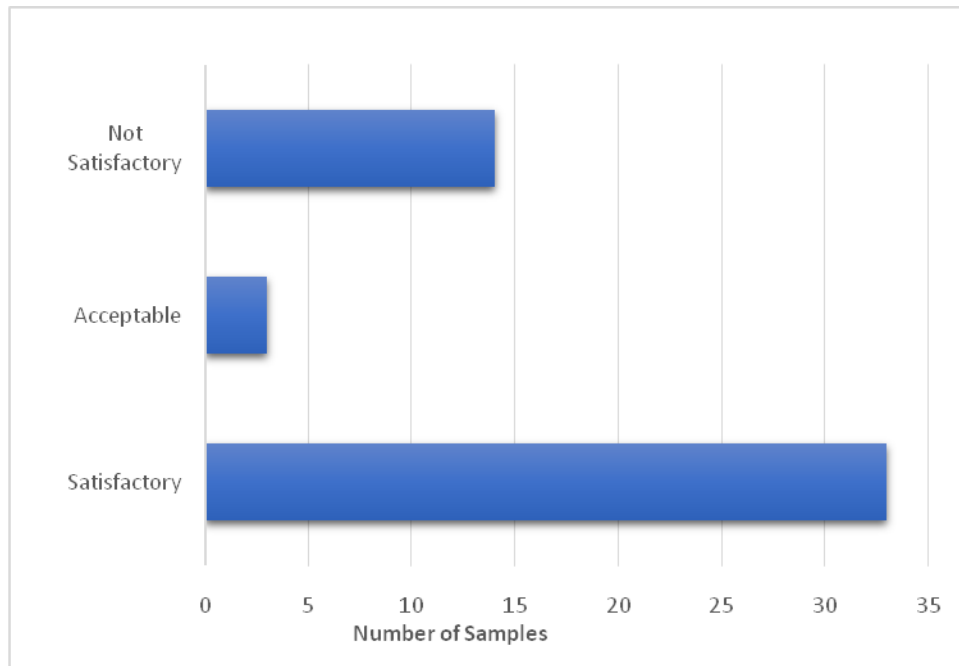
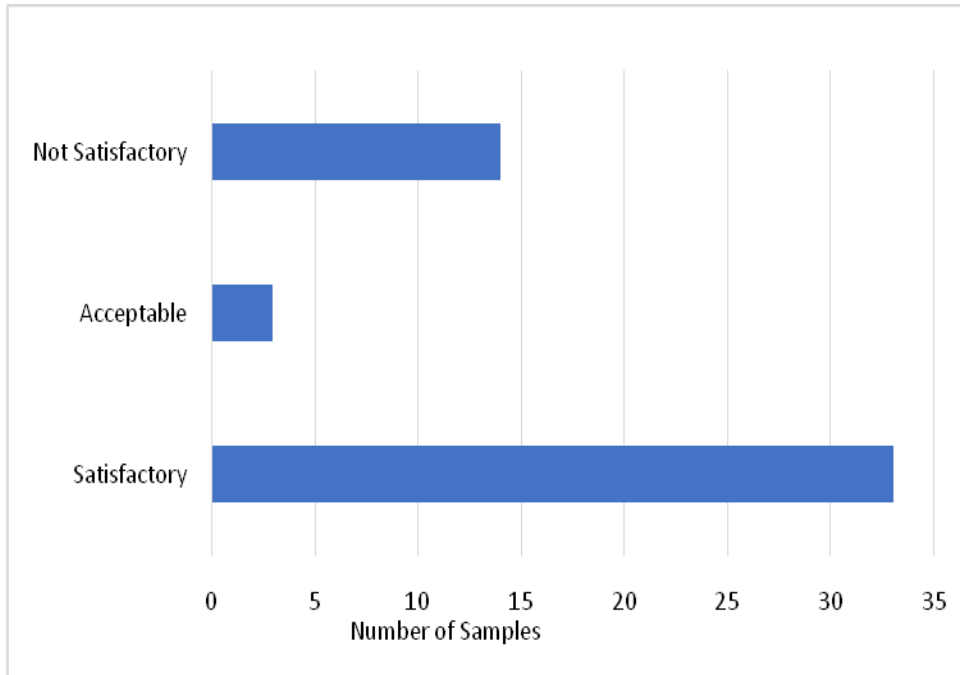


Fig.2 Conformity of the samples

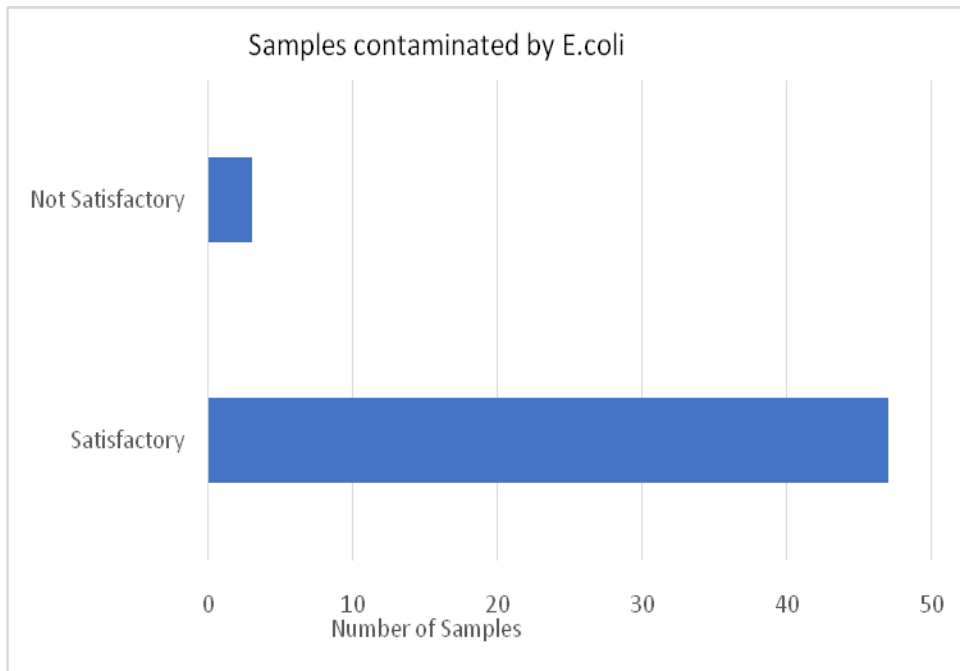




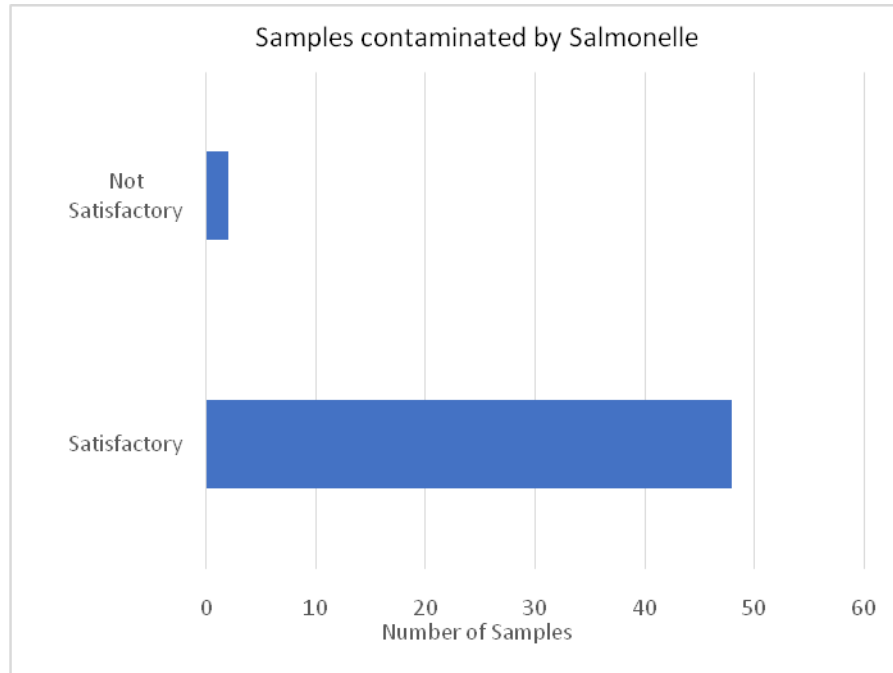
**Fig.3** Level of contamination by the TAFM



**Fig.4** Level of contamination of samples by *E. coli*



**Fig.5** *Salmonella* contamination level



Indeed, the level of education of the mother plays a determining role in the explanation of the nutritional status of the children. We see it, according to INSAH, (2008), in several countries of sub-Saharan Africa (Mali, Chad, Burkina Faso, Niger, Senegal, Cape Verde, Gambia) an inverse relationship between each indicator of child malnutrition and the level of education of the mother. Children of upper-level mothers have the lowest levels of malnutrition. The gaps are particularly large between the levels of malnutrition of children of upper-level mothers and the children of their uneducated peers, with indicators ranging from one to two and sometimes more. Overall, the mother's living conditions would significantly determine the nutritional status of the children.

### **Environment of the respondents**

In general, we found that the respondents' environment is characterized by the presence of stray domestic animals (78%), insects (ants, flies, crickets, small cockroaches)

(86%) and sometimes flasks of water. The latter is characterized by the presence of dwellings in non-final building materials (Banco and Paillotte). More than half (58%) of households do not have a latrine and 70% do not have a source of drinking water. Hand washing with soap is not a common practice among respondents as only 12% say washing their hands with soap. This unsanitary environment is conducive to contamination of pathogenic microbes of animal, human or environmental origin. This contamination is contributed to the deterioration of the nutritional status of children. Indeed, UNICEF's causal pattern of malnutrition identifies diseases as an immediate cause. The WHO says that over three million children under five die each year from causes by affections related to the environment.(WHO, 2018)

In a study done in 2013 at RCAMatkoss, asserts that the rural child, most often without a source of drinking water and a modern toilet, is more vulnerable to malnutrition.

### **Level of food contamination**

Bacteriological analysis of samples taken at Mayahiin children with MAM revealed the presence of 3 types of germs: total aerobic mesophilic flora, *E. coli* and *Salmonella*. The FMAT is an important hygiene indicator, the presence of *E. coli* and that of *Salmonella* indicates usually a faecal contamination.

Overall, 28% of our samples do not comply with CNERNA standards. This degree of contamination may be linked to sanitation where people cooking, storage and handling of food.

The prolonged stay at ambient temperature and the exposure to the open air are two major factors of contamination and multiplication of FMAT in food (Blazy, 1978).

Thus, these foods slightly covered in unhealthy environments are susceptible to contamination by stray animals and fly vectors of microorganisms.

Indeed some dishes cooked as spend the night at room temperature before being summarily warmed to be consumed.

However, it is difficult, from these results, to define all the critical points whose omission increases the risks of contamination. According to Bryan, Some practices such as the use of non-drinking water, dirty dishes of water, inadequate food protection in a dusty atmosphere probably lead contamination by solid debris (sand) and micro –organisms (Bryan, 1988).

These contaminated foods that are sources of infections contribute at weaken the immune system of children and the degradation of their nutritional status. Professors James and Roger say that as little infection as possible can precipitate malnutrition. An infection

leads to a decrease or loss of appetite and an increase in metabolism. There is also the loss of nutrients by stool as in gastroenteritis. Viral infections such as measles in children often result in malnutrition (James Renner and Roger Andrianasolo, 2014).

We have had a high number of microbes in food compared with the figures of the French regulations (CNERNA, 1996).

In Niger, we do not have the regulations in force on the various parameters of food quality, especially on the number and type of germs not to be exceeded at the risk of a food poisoning. The absence of these germs in food is a criterion of guarantee of safety for the health of the consumer.

In conclusion, the work donemade possible to study the microbiological characteristics of food children with moderate acute malnutrition (MAM) in the department of Mayahi and identify the sources of contamination of these foods. The result of the study showed that the environment of the respondents is unsafe, mainly due to the presence of animals at 78%and the absence of latrines in 58% of households. Analysis of the food samples showed a very high mean microorganism load  $4.5.10^6$  UFC/g and the presence of pathogenic bacteria such as *Salmonella* and *E. coli* in some foods. The presence of these microorganisms indicates faecal contamination due to non-compliant hygienic conditions. The presence of faecal contamination germs is an indicator of hazards or risk to the health of the consumer. However, despite all efforts to better prevent food contamination, much work remains to be done to reduce the rate of foodborne illness. Respecting hygiene measures can help improve the quality of these foods but also the literacy of the population, awareness of the latter on the hygiene of the body and the environment, the proper disposal of faeces

and the separation of animals from humans. Training of health and community workers on the link between infections and nutritional status can help to significantly reduce contamination of these foods.

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