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Micro-organisms Associated with Locally Available Infant Weaning Foods in Jos and Environs, Nigeria

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Summary

Ikeh EI, Okwudili PE, Agina ES, Odumodu CU. Micro-organisms Associated with Locally Available Infant Weaning Foods in Jos and Environs, Nigeria. *Nigerian Journal of Paediatrics* **2001; 28:7.** A study was carried out to ascertain the micro-organisms associated with the local cereal-based infant weaning foods in Jos, Nigeria. The sampled weaning foods included maize and sugar; maize, sugar and milk; soya-bean, maize and groundnut; soya-bean, maize, groundnut, egg and banana; guinea-corn and sugar; and millet and sugar. Sixteen micro-organisms were isolated consisting of Bacillus species, *Streptococcus faecalis*, *Streptococcus viridans*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, Lactobacillus species, Pseudomonas species, Klebsiella species, Citrobacter species, *Escherichia coli*, Actinomycetes species, *Neurospora sitophila*, Rhizopus species, Fusarium species, *Aspergillus fumigatus* and *Aspergillus tamarii*. The average microbial load in the sampled weaning foods ranged from 4.9×10^6 to 7.3×10^6 cfu/ml. A few of the micro-organisms are pathogenic, while most of them can cause food spoilage which may result in weanling diarrhoea. All the types of food had equal chances of being contaminated by any of the micro-organisms ($P>0.05$). Also the practice of cooking the pap further to about 95°C for 5 minutes prior to serving significantly reduced the microbial load. The practice of storing large quantities of prepared food for more than 6 hours at room temperature was detrimental to the quality of the food. The environment may also contribute to the incidence of weanling diarrhoea as the average microbial load in the foods from the rural areas was higher than those from urban areas. In order to reduce the morbidity and mortality associated with weanling diarrhoea, efforts should be made to reduce or possibly prevent microbial contamination of prepared local weaning foods.

Introduction

THERE are various types of weaning foods available in the world today ranging from the commercialised artificial feeds to the locally prepared ones. The locally available cereal based infant weaning foods in Jos and environs include fresh cow milk and pap, which is made from different kinds of cereals such as maize, guinea-corn and millet. In order to further enrich this pap, most mothers add all sorts of food items. Some of these are ground fish, half cooked egg, soya-bean, ground groundnut, peanut, ground crayfish, honey and even some canned infant foods such as *Nutrend*® and *Cerelac*®.

Total aerobic counts on food products reflect not only the history of handling, state of decomposition and degree of freshness but also the sanitary quality of the food. Livingstone *et al.*,[1] stated that cooking the weaning foods slurry for 5 minutes at about 95°C reduced the total bacterial count and other spoilage microflora to safe limits.

Several factors could lead to the contamination of these weaning foods; some of which are their sources, mode of preparation and storage, the use of contaminated water and utensils during the prepara-

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tion and exposure of the prepared food to the atmosphere. When micro-organisms grow on food, some of them can cause food spoilage or food poisoning.[2] Also the type of microbial spoilage depends on both the micro-organisms and the composition of the food.[2] Black *et al.*,[3] in their study reported that 41 percent of samples of food items fed to weaning infants yielded *Escherichia coli* which may be an indication of faecal contamination. Erku and Ashenafi[4] in their study of prevalence of food borne pathogens in weaning foods reported 62 percent, 35.2 percent and 2.8 percent for *Staphylococcus aureus*, *Bacillus cereus* and *Salmonella typhi*, respectively. At each step in the preparation of infant weaning foods, the type of contaminating micro-organisms may differ and the consequences of such contamination may also be quite different.[5] The aim of this study was to ascertain the micro-organisms associated with the local cereal-based infant weaning foods in Jos, Nigeria.

Materials and Methods

Collection of Samples

Samples of various types of locally prepared and ready to be served infant weaning foods were collected as aseptically as possible into clean, dry and sterile universal bottles. These samples (n=100) were collected from various homes in Jos and environs (urban and rural). The weaning foods were grouped into 8 according to their components and included: (A) maize and sugar (n=13); (B) maize, sugar and milk (n=13); (C) maize and milk (n=13); (D) soya-bean, maize, groundnut, egg and banana (n=12); (E) soya-bean, maize, groundnut and crayfish (n=12); (F) soya-bean, maize, groundnut, egg and banana (n=11); (G) guinea-corn and sugar (n=13) and (H) millet and sugar (n=13). These samples were collected already cooked and in their paste forms, ready to be served and stored in covered plates, cups or feeding bottles either at room temperature or in the refrigerator at 4°C. The duration of storage after the preparation of the food was noted. As being practised by some of the respondents, some of the samples were further cooked to about 95°C for 5 minutes prior to collection.

Microbiological Analysis of Sample

Ten millilitres of each of the 100 samples of ready-to-serve weaning foods were homogenized with 90ml of sterile phosphate buffered saline (pH 7.2). One millilitre aliquots (5 drops) of serial 10 fold dilutions of the samples with the same buffer were then inoculated into well dried nutrient agar, blood agar and potato dextrose agar plates. The drops were allowed to dry and the inoculated nutrient and blood agar plates were incubated at 37°C while inoculated potato dextrose agar plates were incubated at 25°C for 48 hours and 72 hours, respectively. The tests were set up in duplicates and the viable counts were calculated using standard methods.[6]

The bacterial and fungal cultures from each of the inoculated samples were identified using standard methods.[7] Statistical analysis was done using the analysis of variance at 5 percent level of significance.

Results

In the survey, a total of 16 micro-organisms comprising ten bacterial species, five fungal species and one Actinomycetes were isolated. The bacterial species were Bacillus species, *Streptococcus faecalis*, *Streptococcus viridans*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, Lactobacillus species, Pseudomonas species, Klebsiella species, Citrobacter species and *E. coli*. The fungal species were *Neurospora sitophila*, Rhizopus species, Fusarium species, *Aspergillus fumigatus* and *Aspergillus tamarii*.

Table I shows the micro-organisms isolated from the various groups of sampled weaning foods. Group A foods were contaminated by almost all the isolates (14 isolates). They did not yield Lactobacillus species and Citrobacter species. Groups D,C,B,G,E,H and F were contaminated by 10,8,5,5,3,3 and 1 isolates, respectively. Thus group F which is a mixture of soya-bean, maize, goundnut, egg and banana was the least contaminated.

Table II shows the various micro-organisms and the microbial load from the "cooked" and "uncooked" foods. All the micro-organisms were present in the "uncooked" foods while the "cooked" foods did not contain Pseudomonas species, Citrobacterer species, *N. sitophila*, Fusarium species and Actinomycetes species. The total number of isolates in the "cooked" and "uncooked" foods was 11 and 16, respectively, while the average microbial loads was 5.4×10^6 and 6.8×10^6 cfu/ml, respectively. Thus the "cooked" foods had lower level of contamination.

From Table III, it can be observed that the foods kept for longer periods (more than 6 hours) had higher average microbial load (6.5×10^6 cfu/ml) than the foods that were kept for less than 6 hours (6.2×10^6 cfu/ml). The number of isolates in the foods served within 6 hours of preparation was 10 as against 14 in those served beyond 6 hours of preparation. The samples from the rural areas had higher average microbial load (7.3x10 cfu/ml) and more isolates (15) compared with those from urban areas with average microbial load of 4.9×10^6 cfu/ml and 6 isolates.

Table I

Micro-organisms Isolated from the Various Sampled Weaning Foods in Jos. Nigeria

Micro-organisms	*Types of Weaning Foods*							
	A (n=13)	*B* (n=13)	*C* (n=13)	*D* (n=12)	*E* (n= 12)	*F* (n=11)	*G* (n=13)	*H* (n=13)
Bacillus sp.	+	+	+	+	+	+	+	+
Streptococcus faecalis	+	+	+	+	-	-	+	-
Streptococcus viridans	+	-	+	+	-	-	-	-
Staphylococcus epidermidis	+	+	+	-	-	-	+	-
Staphylococcus aureus	+	+	+	+	-	-	-	+
Lactobacillus sp.	-	-	-	+	-	-	-	-
Pseudomonas sp.	+	-	-	-	-	-	-	-
Klebsiella sp.	+	-	+	+	+	-	-	-
Citrobacter sp.	-	-	-	+	-	-	-	-
Escherichia coli	+	+	+	+	+	-	-	+
Neurospora sitophila	+	-	-	-	-	-	-	-
Rhizopus sp	+	-	+	-	-	-	-	-
Fusarium sp.	+	-	-	-	-	-	-	-
Aspergillus fumigatus	+	-	-	+	-	-	+	-
Aspergillus tamarii	+	-	-	+	-	-	+	-
Actinomycetes sp.	+	-	-	-	-	-	-	-
Total	14	5	8	10	3	1	5	3

n = no of samples
+ = Present
- = Absent
A = Maize and sugar
B = Maize, sugar and milk
C = Maize and milk
D = Soya-beans, maize and groundnut
E = Soya-beans, maize, groundnut and crayfish
F = Soya-beans, maize, groundnut, egg and banana
G = Guinea-corn and sugar
H = Millet and sugar

Table IV shows the frequency of occurrence of the micro-organisms from the various weaning foods. Bacillus species had the highest frequency of occurrence (29) followed by *S. aureus* (9),*E. Coli(9), S. epidermidis* (7), *S. faecalis(7),S. viridans* (5), Klebsiella species (4), Actinomycetes species (2), *A. fumigatus* (2) and one each of Lactobacillus species, Pseudomonas species, Citrobacter species, *N. sitophila* and Fusarium species.

Table V describes the distribution of the different groups of micro-organisms isolated from the various groups of weaning foods. Bacteria had the highest frequency of occurrence, followed by fungi and Actinomycetes with 78, 12 and 2, respectively. The analysis of variance showed that at 5 percent level of significance, there was no significant difference in the type of micro-organisms that contaminated any particular type of weaning food ($P>0.05$). Thus all the types of weaning foods had equal chances of being contaminated by any of the three groups of micro-organisms if they were exposed to them.

Table II

Comparison of Micro-organisms Isolated from "Cooked" and "Uncooked" Prepared Weaning Foods

Micro-organism	*"Cooked" Food (n=50)*	*"Uncooked" Food (n=50)*
Bacillus sp.	+	+
S. faecalis	+	+
S. viridans	+	+
S. epidermidis	+	+
S. aureus	+	+
Lactobacillus sp.	+	+
Pseudomonas sp.	-	+
Klebsiella sp.	+	+
Citrobacter sp.	-	+
E. coli	+	+
N. sitophila	-	+
Rhizopus sp.	+	+
Fusarium sp.	-	+
A. fumigatus	+	+
A. tamari	+	+
Actinomycetes sp.	-	+
Total	11	16
Average Microbial Load	5.4×10^6	6.8×10^6

\+ = Present
\- = Absent
"Cooked" = Food was further cooked to 95°C for 5 minutes after it has been prepared.
"Uncooked" = Food that was not cooked again after preparation.

Table III

Micro-organisms Isolated from Weaning Foods at Different Times and Locations

	Duration of Storage after Preparation		*Location*	
Micro-organisms	*<6 hours (n=50)*	*≥6 hours (n=50)*	*Rural Areas (n=60)*	*Urban Areas (n=40)*
Bacillus sp.	+	+	+	+
S. faecalis	+	+	+	-
S. viridans	+	+	+	+
S. epidermidis	+	+	+	-
S. aureus	+	+	+	-
Lactobacillus sp.	+	-	+	+
Pseudomonas sp.	-	+	+	-
Klebsiella sp.	+	+	+	+
Citrobacter sp.	+	-	+	-
E. coli	+	+	+	+
N. sitophila	-	+	+	-
Rhizopus sp.	-	+	+	-
Fusarium sp.	-	+	-	-
A. fumigatus	-	+	+	+
A. tamari	-	+	+	-
Actinomycetes sp.	+	+	+	-
Total	10	14	15	6
Average Microbial Load (cfu/ml)	6.2×10^6	6.5×10^6	7.3×10^6	4.9×10^6

Rural Areas = Angwan Rogo, Dutse Uku
Urban Areas = JUTH, Bauchi Road, Massalachi Jumai, New Market Road.

Discussion

This study has implicated some of the micro-organisms that are capable of contaminating and multiplying in locally available infant weaning foods in Jos, Nigeria. These weaning foods are also used in other northern parts of the country. A few of the micro-organisms are of intestinal origin, thus indicating that the prepared foods must have been contaminated somewhere along the line before being fed to the infants. The isolation of these indicator organisms may suggest that the foods can also be contaminated with enteropathogens such as Salmonella and Shigella species among others, with the resultant adverse health conditions. The isolation of *S. aureus* from some of the weaning foods is not desirable as some phage types of this organism can cause food poisoning. Thus, the contamination of weaning foods by micro-organisms can result in serious health problems such as weanling diarrhoea as well as result in unfavourable changes in the taste of the prepared foods due to spoilage. This ultimately results in the rejection of the prepared food by the infants, which may give rise to malnutrition. The preponderance of Bacillus species in all types of sampled weaning foods is because of the ubiquitous nature of this organism.

The practice of "cooking" the pap further to 95°C for 5 minutes can significantly reduce the microbial load of the food. The study also shows that foods that were stored at room temperature for less than 6 hours after preparation had lower average microbial load and fewer isolates than those stored for longer

Table IV

The Frequency of Occurrence of Micro-organisms Isolated from the Weaning Foods

Micro-organisms	*Types of Weaning Foods*								*Total*
	A (n=13)	*B* (n=13)	*C* (n=13)	*D* (n=12)	*E* (n=12)	*F* (n=11)	*G* (n=13)	*H* (n=13)	
Bacillus sp.	13	1	3	4	1	2	3	2	29
S. faecalis	3	1	1	1	0	0	1	0	7
S. viridans	3	0	1	1	0	0	0	0	5
S. epidermidis	3	1	2	0	0	0	1	0	7
S. aureus	4	1	2	1	0	0	0	1	9
Lactobacillus sp.	0	0	0	1	0	0	0	0	1
Pseudomonas sp.	1	0	0	0	0	0	0	0	1
Klebsiella sp.	1	0	1	1	1	0	0	0	4
Citrobacter sp.	0	0	0	1	0	0	0	0	1
E. coli	4	1	1	1	1	0	0	1	9
N. sitophila	1	0	0	0	0	0	0	0	1
Rhizopus sp.	3	0	1	0	0	0	0	0	4
Fusarium sp.	1	0	0	0	0	0	0	0	1
A. fumigatus	1	0	0	1	0	0	0	0	2
A. tamari	1	0	0	2	0	0	1	0	4
Actinomycetes sp.	2	0	0	0	0	0	0	0	2
Total	41	5	12	17	3	3	7	4	92

n = Number of samples
A = Maize and sugar
B = Maize, sugar and milk
C = Maize and milk
D = Soya-beans, maize and groundnut
E = Soya-beans, maize, groundnut and crayfish
F = Soya-beans, maize, groundnut, egg and banana
G = Guinea-corn and sugar
H = Millet and sugar

periods at the same temperature. It is believed that the storage of the prepared weaning foods in refrigerators will at least prevent the multiplication of any contaminating micro-organisms, thus preventing the production of toxins or the ingestion of undesirable numbers of micro-organisms. It is also a known fact that most of the mothers that use these local foods are in the low-income group and therefore may not afford the luxuries of electricity. Also, where the electricity is provided, there may be prolonged power failure and this will adversely affect the quality of prepared foods stored in refrigerators.

The prepared weaning foods obtained from the

Table V

Distribution of the Different Groups of Micro-organisms Isolated from the Weaning Foods

Micro-organisms	*Types of Weaning Foods*								*Total*
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	
Bacteria	32	5	11	14	3	3	6	4	78
Fungi	7	0	1	3	0	0	1	0	12
Actinomycetes	2	0	0	0	0	0	0	0	2
Total	41	5	12	17	3	3	7	4	92
Mean	13.67	1.67	4.0	5.67	1.0	1.0	2.33	1.33	

A = Maize and sugar
B = Maize, sugar and milk
C = Maize and milk
D = Soya-beans, maize and groundnut
E = Soya-beans, maize, groundnut and crayfish
F = Soya-beans, maize, groundnut, egg and banana
G = Guinea-corn and sugar
H = Millet and sugar

rural areas yielded higher levels of contamination, thus confirming that the environment contributes significantly to the incidence of weanling diarrhoea. Mothers should resist the temptation of either storing the prepared foods at room temperature for long duration or preparing them in quantities sufficient to meet the needs of the day rather than one meal. Efforts should also be made to maintain good standards of hygiene on the part of the prepared food, the environment and the attendant. These precautions will definitely improve the microbiological quality of our locally prepared cereal-based infant weaning foods and thus reduce the incidence of weanling diarrhoea in our environment.

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