

Research Article

Geophagy: a survey on the practice of soil consumption in N'Djamena, Chad

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Background

Geophagy, the recurrent intentional eating of soil, is well documented in many African countries, but little or nothing is known about this practice in Chad. We conducted a cross-sectional study among inhabitants of N'Djamena to assess: (i) source, type, and form of geophagic soil at purchase; (ii) event, daily frequency, daily cost, and duration of soil eating; (iii) habits at consumption and storage; (iv) specific motivation of soil eating and habit-forming events; (v) expected health benefits and awareness of health risks; and (vi) chance for intervention.

Methods

One main food market was randomly selected in each of the 10 districts of N'Djamena. In each food market, 10 vending points of geophagic soil were randomly selected. In each vending point, one geophagist was interviewed. A total of 100 geophagists (residents in N'Djamena) completed a self-reported structured questionnaire on hard copy. Outcomes were analyzed using IBM SPSS statistics 20.0 software.

Results

The main group of geophagists in Chad is represented by women in childbearing age (30.4 years old). Geophagic soil is generally locally extracted and easily available at the food market (77%). Kaoline is the most consumed soil (63%) followed by laterite (29%). Soil is preferentially consumed granulated (66%) or crushed (23%), but also in powder. Protective effect against cancer and gastritis figures out as main (35%) expected benefit of the practice, followed by protection against nausea and vomiting (25%) and pain (19%). One in 4 geophagists eats soil due to pleasure at taste, and some (2%) just follow the habit without specific purpose of pleasure. Geophagy in Chad is a culturally-transmitted form of pica. Interestingly, even if the vast majority of geophagists (94%) is unaware and uninformed about health risks of soil eating, the 43% were against the option of recommending it.

Conclusions

Based on these findings, we recommend awareness campaigns on: (i) the health risk of soil eating, (ii) erroneous beliefs, e.g., the protective effect of geophagic soil against cancer, and (iii) the misleading communication subtended by the vending of soil among food items.

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) classifies Pica as the habitual intentional consumption of non-food and non-nutritive substances (like laundry starch, ice, soap, chalk, and kaolin) for at least one year (Diagnostic and Statistical Manual of Mental Disorders, DSM-5). Pica disorder is usually unnoticed, under-reported, and causes serious harm to consumers.¹ Pica is

categorized into 36 different typologies² among which the most common are amylophagy (eating raw starch), pagophagy (eating large quantities of ice) and geophagy.³ Geophagy is the recurrent intentional, craving and purposive eating of soil, in particular clay substances. The practice of geophagy is deeply embedded in cultural traditions, and in many cultural contexts earth eating is seen as nor-

mal. Due to the increasing environmental (chemical, microbiological, physical) hazards and the practice prevalence among the most biologically vulnerable populations with potentially adverse health consequences, geophagy has become a public health concern.^{4,5} As observed and documented in many areas of the world for at least two millennia, geophagy is widespread in sub-Saharan Africa. Very little is currently known about geophagy practice in Chad. Based in N'Djamena, Chad, this study sought to collect data on: source, type, and form of geophagic soil at purchase; event, daily frequency, daily cost, duration of soil eating; habits at consumption and storage; specific motivation of soil eating and habit-forming events; expected health benefits and awareness of health risks; chance for intervention.

METHODS

STUDY SITE

N'Djamena (N 12° 06, E 15° 02) is the capital and largest city of the Republic of Chad. It is located in the center-west of the country, on both banks of the Chari River. Its population is estimated at 1,178,361 inhabitants, with an average density of 2356.72 inhabitants/km² as per the 2015 census. The city is divided in 10 districts. Each district has 2-3 main markets. The climate is Sahelian, marked by a dry season (November-April) and a rainy season (May-October). The annual average rainfall is 510 mm with a maximum rainfall in the month of August (175 mm). The average maximum temperature is 41°C in April while the minimum can drop to 14°C in January. Indeed, climate is of paramount importance in studies investigating the risk of carry-over of contaminants from the environment to humans.⁶

PARTICIPANTS

We conducted a regional based cross-sectional study using a structured questionnaire on November and December 2020. We visited 1 randomly selected main food market in each of the 10 district of N'Djamena city. In each food market we randomly selected 10 vending points of geophagic soil. In each vending point, we interviewed 1 geophagist coming for purchasing soil. In total, we interviewed 100 geophagists, i.e. 10 geophagists distributed in 100 randomly selected selling points in 10 food markets distributed in the 10 districts of the city. Participants enrolled in the study on voluntary basis. They had diverse ages, according to the exclusion criteria of under 15, above 65, and mental ill.

QUESTIONNAIRE

A standardized, anonymous, self-administered open-ended questionnaire designed specifically for the study was used. Its purpose was mainly to investigate knowledge and practice of geophagy. A preliminary structured questionnaire was developed following a review of published literature to suit the research needs.² The questionnaire was tested for reliability, validity and accuracy. The pre-test was undertaken on a randomly selected sample of 10 participants in

each district of N'Djamena, based on mentioned inclusion criteria. People sampled in the pre-test were not included in the study. Based on the pre-test feedback, necessary modifications of the questionnaires were carried to avoid misleading information. The final questionnaire consisted of 20 questions: 4 on general information, 8 on knowledge and practice of geophagy, and 8 on the reason/motivation for geophagy.

DATA COLLECTION AND ANALYSIS

Participants were invited to complete a self-administered questionnaire. The interviewer monitored the participant while filling the questionnaire so as to avoid interferences and preserve independent answers. The answered questionnaires were then harvested and processed for data entering and analysis. The data were analyzed using IBM SPSS statistics 20.0 software.

RESULTS

In the study, 100 inhabitants of N'Djamena participated and completed the questionnaire. The majority in the sampled population were women (98%) within the age range of 17-65 (mean age 30.4); most of the participants (61%) were 15-31.

The majority of them always got the soils from the local markets (77%) while others got them also from neighboring countries like Cameroon and Nigeria (Table 1). Among soil types, kaolin figured out as the most consumed soil followed by laterite (Figure 1); some individuals reported to eat kaolin and laterite together or a mixture of them with other soils. A slightly greater proportion of respondents in the age group 15-30 preferred kaoline followed by laterite. Pearson Chi-Square = 6.245 revealed that age is significantly associated with soil type consumed (pv. 283) (Table 2).

Granulated soil was the preferred consumed form, followed by crushed and powdered soils (Table 1). Granulate and crushed soils were the most consumed forms of soil in both age groups (15-30; 31-65). Pearson Chi-Square 6.917 revealed that age groups were significantly associated with the form of soil consumed by the study participants (pv > 0.227) (Table 3).

The majority of subjects practiced soil eating for at least 4 times/day and spent about 50-150 FCFA depending on soil type. The practice was very common during pregnancy (56%), to mitigate nausea, gastritis, sickness, and pain (15%), at any time of life (14%) or rare (7%). Interestingly, the 8% of subjects consumed soil independently of specific event (Table 4).

Concerning the individual history of soil eating, 66% of the respondents practiced geophagy for at least 5 years, 22% for 6-10 years, and 12% reported to have been practicing geophagy for over 10 years (Table 4).

With regards to preparation, 84% of respondents reported that they either suck or crush soil before eating, 5% do that during meals, and 11% dissolve soil in water (Table

Table 1. Source, type, and form of geophagic soil at purchase, according to this pilot survey.

SOURCE	%	TYPE	%	FORM	%
Chad (market, river, pits, wells, holes)	77	Kaolin	63	Granulated	66
Cameroon	18	Laterite	29	Crushed	23
Cameroon and Nigeria	3	Koalin/laterite	4	Powder/crush	8
Nigeria	1	Koalin/others	2	Granulated/powder	1
I don't know	1	Kaolin/laterite/others	1	Granulated/crushed	1
		Laterite/others	1	Powder	1



Figure 1. Types and forms of geophagic soils commonly marketed in N'Djamena, Chad.

Table 2. Soil type consumed by age group.

	kaolin	laterite	kaolin/ laterite	kaolin/ laterite/ others	koalin/ others	laterite/ others	Total
15-30 years	37(60.7%)	17(27.9%)	4(6.6%)	0(0.0%)	2(3.3%)	1(1.6%)	61
31-65 years	26(66.7%)	12(30.8%)	0(0.0%)	1(2.6%)	0(0.0%)	0(0.0%)	39
Total	63(63.0%)	29(29.0%)	4(4.0%)	1(1.0%)	2(2.0%)	1(1.0%)	100

Table 3. Forms of soil consumed by age group.

	granulated	powder	crushed	granulated/ powder	granulated/ crushed	powder/ crush	Total
15-30 years	41(67.2%)	1(1.6%)	11(18.0%)	0(0.0%)	1(1.6%)	7(11.5%)	61
31-65 years	25(64.1%)	0(0.0%)	12(30.8%)	1(2.6%)	0(0.0%)	1 (2.6%)	39
Total	66(66.0%)	1(1.0%)	23(23.0%)	1(1.0%)	1(1.0%)	8(8.0%)	100

5). Most of them store the soil in package at home (95%) while the 5% of them store geophagic soil outdoor.

Regarding specific reasons or motivation for the practice of geophagy, majority of the respondents confirmed pregnancy as main motivation followed by pleasure at taste,

Table 4. General characteristics of soil eating (event, daily frequency, daily cost, duration) in N'Djamena, Chad.

EVENT	%
Pregnancy	56
Nausea/gastritis/sickness/pain	15
At any time	14
Rarely	7
No reason	8
FREQUENCY/DAY	%
1 -3 times	46
>4 times	54
COST (FCFA)/DAY	%
50-150	97
160-1300	3
DURATION	%
0-5 years	66
6- 10 years	22
> 10 years	12

Table 5. Geophagy: habits at consumption and storage, according to this pilot survey.

CONSUMPTION	%	STORAGE	%
Suck/crunch	84	Plastic bags/bags/hand bags	86
Within meal	5	Cups/small jars	9
Dissolved in water	11	Outdoor	5

zeal for improved skin texture, and mitigation of diseases' symptoms (Table 6). With respect to habit forming event, most of the respondents indicated both personal predisposition to the geophagy practice and suggestion by a friend, or family members (sister, mother) (Table 6). In this frame, it was interesting to figure out how geophagic soil is always sold at the food market, because it is appreciated by part of the population (Figure 2). This suggested to the authors a subtending bias towards consumers' conceiving of soil as something useful from the nutritional viewpoint (e.g. nutraceutical).

With regards to the supposed advantages of geophagy, 35% of the respondents reported expected protective effect against diseases like cancer and gastritis, 25% of them reported expected effect in mitigating nausea and vomiting, while 19% of them expect mitigation of pain. Only 2% of respondents seem not to have specific expectation on the geophagy practice, and 25% of them just expect pleasure from palatable soil (Table 7). As for the health hazards, 95% were completely unaware of geophagy related risks for health due to exposure to hazards like pathogens, toxic chemicals and radioactive substances (Table 7).

Interestingly, 57% of the respondents were ready to recommend the practice to others, while 43% of them were

Table 6. Specific reasons or motivation for the geophagy practice, and habit-forming events, according to the present survey.

MOTIVATION	%	HABIT ORIGIN	%
Pregnancy	42	Nobody	39
Good taste	34	Friend	39
Improved skin texture	11	Sister	15
Diseases during pregnancy	3	Mother	7
Disturbs during pregnancy	5		
Diseases	4		
Disease and disturbs during pregnancy	1		



Figure 2. Geophagic soil is sold among food items at the food market in N'Djamena, Chad.

against the option of recommending it (Table 8). The 94% of the respondents never received warning about the risk for health posed by the ingestion of soil.

DISCUSSION

To our knowledge, this is the first exploratory study conducted on the geophagic practice in Chad thus far. Geophagy is a common practice in N'Djamena. Of the 100 soil eating participants, 98% were women and 61% were between the age 15-31 (mean age 30.4), thus confirming women in childbearing age as main population sub-group practicing geophagy. In general, women (mainly during pregnancy, lactation, or in postpartum) and children are the most common consumers of soil, while geophagy is rarely reported by men.⁷ Our findings confirm how some

Table 7. Expected health benefits and awareness of risks possibly associated with ingestion of geophagic soil, according to the present survey.

BENEFITS	%	AWARENESS OF RISKS	%
Avoid diseases (gastritis, cancer)	35	No	93
Avoid nausea/vomiting	25	Yes	7
Avoid pain	19		
Good taste	19		
I don't know	2		

Table 8. Propagation of the practice, according to the survey, and chance for intervention on this culture-rooted habit.

Would you recommend geophagy to others?	%	Has anyone ever warned you about the risks of consuming soil?	%
No	43	No	94
Yes	57	Yes	6

men eat soil in secret, due to the general attribution of this practice to women. The prevalence of geophagy among pregnant women found in this study (56%) is in line with the scenario of west and east Africa (65-73%).⁸⁻¹¹ The findings of this study substantiated the following considerations discussed below.

Out of craving for non-food products (e.g. kaolin, also known as white dirt chalk, or white clay) during pregnancy to relieve nausea and abdominal troubles, control diarrhea, increase salivation, remove toxins and alter odor or taste, consumption of soil seems also being influenced by smell and taste. About the habit-forming reasons, our findings are in line with studies demonstrating the role of family, friends and personal curiosity.¹² Indeed, geophagy has multifactorial motivation, where physiological and cultural factors are central.⁴ Both vendors and consumers should be informed of the potential deleterious effects of eating soil¹³ due to e.g. aerobic bacteria, enterobacteriaceae, fungi^{7,14} and metals/metalloids like arsenic, cadmium, lead, mercury, and nickel.^{7,15-18} Moreover, recent findings highlight how geophagic matrices could reduce the bioavailability of micronutrients while introducing toxic substances¹⁹; the understanding of personal habits are crucial for proper diagnoses in medical settings.²⁰

Noticeably, geophagic samples in Chad mainly come from local sites. Kaolin figures out among the country's natural resources (along with petroleum and natron) and this finding could motivate *ad hoc* studies on the safety (and relevant seasonality) of local clay quarries. The possible use in cosmetics should be assessed, as well: this study highlighted the role of clays also in this field (e.g., skin texture).

Due to culture rooted nature of geophagy, huge scientific evidence (e.g. Chad-specific health risk assessment of soil consumption) is needed to convince medical doctors and traditional healers to be proactive in managing the benefits-to-risk ratio of this traditional practice/remedy in ethno-medicine).²¹

Interestingly, 57% of the respondents were ready to recommend the practice to others, while 43% of them -while uninformed and unaware of risks- were against the option of recommending it. Indeed, this information throws a light on the perception trend growing in the population. Analyzing people's preparedness and proactivity on previously unrecognized/overlooked exposure scenario put important milestones towards awareness raising, informed choice, and empowerment of communities.^{22,23}

The widespread unawareness about the health risk of soil eating linked with unfounded belief in health protective effect against diseases like cancer highlight the urgent need of awareness campaigns. Noteworthy, specific damaging effects of geophagy such as anemia and intestinal troubles are well documented.²⁴

The vending of geophagic clays among food items at food market should be prohibited to avoid feeding the misleading idea of geophagic clays as nutraceutical (Figure 3).¹⁶

CONCLUSIONS

From this study, which appears to be the first conducted in Chad thus far, soil ingestion is a "culture-bound syndrome", i.e. an ancestral tradition and a culturally-transmitted form of pica, apparently not selectively associated with other psychopathology. The observed trend against the option of recommending the ingestion of soil suggests an increasing negative perception of the geophagic practice. This is all the more interesting if we consider that the same subjects were uninformed and unaware of health risks posed by geophagy. Based on the findings of this work, we recommend awareness campaigns on: i) the health risk of soil eating, ii) the erroneous belief of, e.g., its protective effect against cancer, iii) the misleading communication subtended by the vending of soil among food items. Evidence-based discussion with medical doctors and traditional healers will benefit of health risk assessment of geophagic Chadian samples and context-specific safety assessment of local quarries.

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Figure 3. Local vendor of geophagic soil at the Dembé market, N'Djamena, Chad.

AUTHORS' CONTRIBUTION

DK and CF conceptualization and design of the investigation, writing; LNN, MB, AH field interviews; AT supervision.

COMPETING INTERESTS

The authors completed the ICMJE Disclosure of Interest Form (available upon request from the corresponding author) and disclose no relevant interests.

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