INVENTORY OF SOME ENVIRONMENTAL COMPONENTS IN THE TERRESTRIAL AND AQUATIC ECOSYSTEMS OF THE INTEGRATED WASTE TREATMENT FACILITY MAKURDI BENUE STATE, NIGERIA.

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ABSTRACT

A survey of some environmental components in the terrestrial and aquatic ecosystems in the Integrated Waste Treatment Facility in Makurdi was carried out to obtain baseline information on the area. Inventory, semi-structured interviews and field observations/walks were carried out to obtain information on useful plants, their abundance and distribution within the facility. The micro and macro flora of the facility was sampled and analyzed using the serial dilution method. 77 plant species consisting of 23 species of trees, 6 shrubs, 34 herbs, 3 woody climbers, 3 climbers, 2 woody herbs, bryophytes, mushrooms and lichens were identified and recorded.17 animal species consisting of 9 mammals, 4 rodents and 4 fish species have being seen and caught within the facility and in Jamo stream. The microbial status of the water indicated that total coliforms ranged from 3.50 x 10^5 to 9.00 x 10^5 cfu/ml faecal coliforms ranged between 4.5 x 10^4 to 2.75 x 10^5 cfu/ml. These indicate a high level of contamination of the water from animal and organic matter and may harbour human pathogenic microorganisms. The organisms identified were Escherichia coli, Aerobacter aeroginesa, Faecal streptococcus, Bacillus aureus. Others were Escherichia ferundii, Salmonella typhosa, Pseudomonas aerogenosa, Aspergillus spp,Penicillium spp and yeasts.

INTRODUCTION

Environmental Impact Assessments (EIA) are carried out to determine whether statutory requirements will be met or whether a development project will be deemed environmentally acceptable when fully operational(Harris *et al* 1996).The EIA of the proposesd Integrated Waste Treatment Facility(IWTF) in Makurdi was carried out as an intergral part of the design, planning and approval process by the Technical Working Group(TWG) of the Department For International Development (DFID) funded State and local Government Programme (SLGP).The total area of the IWTF was found to be 4.42ha with the lowest contour occurring at 96m while the highest contour occurred at 109m and a mean annual precipitation of 1093mm. The disposal of refuse by microorganisms is one of the oldest biological waste treatment systems. Man has buried unwanted refuse for centuries and the microorganisms have broken the complex organic compounds into simple compounds which have been reused by higher plants. Today, there are two classes of refuse disposal by microorganisms; sanitary landfill and composting. In either case, the operation relies partly on microbial activities to transform the waste materials. One major problem in handling municipal waste is that microbial activities are well advanced before the materials reach the composting area. Thus, the waste materials constitute a potential source of pathogenic and non-pathogenic organisms. When rain water hits the ground, a portion of it runs off below and above the ground surface. It picks up many substances as it flows into rivers, streams, or ponds, microorganisms, organic matter and minerals. Being rich in nutrients, it becomes a perfect medium for the growth of

microorganisms. Water has long served as a mode of transmission of diseases. The common human pathogenic bacteria and protozoa found in water include *Salmonella* spp, *Shigella dysenteriae*, *Vibro cholerae, Entamoeba histolytica* and viruses. The main objective of the study was to identify and understand the major environmental components in the proposed facility inorder to provide information for effective impact analysis and mitigation.

METHODOLOGY

Species inventory, abundance and distribution

Investigation of the floristic composition was carried out to generate information on plant distribution , abundance , economic importance/values, among others of the proposed site and surrounding area. Eight quadrates made up of a pair of "reference" plots each were situated within and outside the proposed project site to identify plant species within the reference plots and the number of plants per species in each plot. The reference plots were marked with iron plates indicating the plot number and planted at the edges of the plots. The quadrate size was determined and species area curve for several quadrates sizes were plotted and 10m^2 was adjudged the best. The method of Onyekwelu and Okafor (1979) was employed in laying the quadrates. In each quadrate, all the plant species were identified and counted. Those plant species difficult to identify on the spot were taken to the Herbarium of the Department of Biological Sciences , University of Agriculture Makurdi for identification and checked with Agishi (2004),Keay (1989) and determination keys provided by Arbonnier (2004). Inventory of species, semi-structured interviews and field observations (Balemie and Kebebew, 2006) were conducted with local residents around the study area to obtain information on plants and animals utilized within the area. Active users of wild plants made up of herbalists, hunters, house wives, young people and the aged in the area participated in the interview. The people made a collection of all useful wild plants in the facility and assembled them for identification. The plants were identified and classified according to use categories.

Microbial Evaluation of Soil and Water in the study area

Soil samples were taken within the project site and at the reference plots/quadrates. Each of the samples was wrapped in aluminum foil and analyzed in the laboratory by serial dilution method. The samples were inoculated with nutrient agar and potato-dextrose agar for bacteria and fungi respectively. The emerging colonies after three days of incubation were counted and recorded. The colonies were also examined individually by biochemical tests to identify the species of the organisms. Water samples were collected from Jamo stream in five different locations at 100m intervals, thoroughly homogenized by mixing and tested immediately to avoid contamination . The multiple tube fermentation method using the Most Portable Number (MPN) for coliform bacteria was adopted in the analyses. Prior to the sample collection, a sterile broth was prepared using MacCoukey broth in fermentation tubes. The tubes were then inoculated with the samples and incubated at 35°C for 48 hrs for total coliform bacteria. These were incubated at 44°C in the incubator to obtain results for faecal coliform bacteria count. Soil samples were taken from the same quadrates used for flora evaluation. Samples were also taken

within the project site and reference plots/quadrates referred to as Eco-Control. Each of the samples were wrapped in an aluminum foil, taken to the laboratory and treated within 2 hours after collection (Oshode *et al*, 2008) and analyzed by serial dilution of the samples in accordance with Paul and Clark (1988). The samples were inoculated on nutrient agar and potato-dextrose agar for bacteria and fungi respectively. The emerging colonies after three days of incubation were counted and recorded. The pure cultures of the colonies were also examined by biochemical tests to identify the species of the organisms.

RESULTS

Table 1: Species abundance and distribution in the study area

Species	PLOT I WITHIN	PLOT I CONTROL	PLOT II WITHIN	PLOT II CONTROL	PLOT III WITHIN	PLOT III CONTROL	PLOTIV WITHIN	PLOT IV CONTROL	TOTAL
Asystasia calycina, H	-	-	-	-	-	-	-	10	10
Lannea schimperi, T	1	-	2	-	-	-	1	-	4
Annona senegalensis, S	1	7	-	-	-	-	2	-	10
Voacanga Africana, T	-	-	-	1	-	-	-	1	2
*Spathodea campanulate,*T	-	1	-	-	-	4	-	-	5
*Stereospermum kunthianum,*T	6	-	-	-	-	-	1	-	7
Chamaecrista mimosoides, H	40	-	100	10	30	-	10	-	190
Maytenus senegalensis,	1	1	-	-	-	-	-	10	12
*Anogeissus leiocarpus,*T	-	1	5	-	-	-	-	2	8
Combretum nigricans, T	3	-	-	-	2	-	-	1	6
Terminalia schimperiana, T	-	-	-	-	-	-	-	-	-
Aspilia helianthoides, H	-	100	100	-	-	200	-	-	400
Chromolaena odorata, WH	-	50	-	-	4	1	-	50	105
Tridax procumbens, S	-	-	-	-	300	-	-	-	300
Vernonia amygadalina, S	-	-	-	-	1	-	-	-	1
Antidesma venosum, T	-	-	-	-	-	1	-	-	1
Bridelia ferruginae, T	10	1	-	-	2	-	-	-	13
Bridelia scleroneura, H	-	-	-	-	-	-	1	-	1
Euphorbia heterophylla, T	-	-	-	-	200	-	-	-	200
Fluggea virosa, T	1	2	-	2	2	-	-	-	7
Phyllantus amarus, H	-	-	-	-	-	1	-	-	1
Calopagonium mucunoides, H	-	-	-	1	-	-	-	-	1
Crotalaria retusa, H	80	-	-	1	-	-	-	-	81
Desmodium velutinum, H	-	-	-	-	-	-	3	10	13
Eriosema psoraleoides, WH	-	3	-	-	-	-	-	-	3
Indigofera dendroides,	-	-	-	-	4	-	-	-	4
Indignofera heudelotii,	-	-	-	-	-	1	-	-	1
Mucuna poggei, H	-	-	-	-	80	-	-	-	80
Tephrosia bracteolate, H	100	100	200	10	300	-	50	-	760
Hymenocardia acida, T	3	-	-	-	-	-	-	-	3
Spigelia anthelmia, H	-	-	-	2	-	-	-	-	2
Hibiscus aspera, H	100	-	-	-	-	-	-	-	100
Sida rhombifolia, H	-	-	-	-	-	-	-	-	-
Azadirachta indica, T	1	10	-	-	-	1	-	10	22
Khaya senegalensis, T	1		-	-	-	-	-	-	1
Pseudocedrela kotchyi, T	-	-	-	-	-	-	30	-	30
Trichilia emetic, T	6	-	-	-	-	-	-	-	6

Cissampelos mucronata, C	-	-	-	2	-	-	-	-	2
Acacia polyacantha, T	-	-	-	1	-	-	-	-	1
Parkia biglobosa, T	1	4	-	-	-	-	1	1	7
Prosopis Africana, T	1	1	-	-	-	-	1	-	3
Ficus sur, T	-	1	-	-	-	-	-	-	1
Elaeis guineensis, T	-	-	-	-	1	2	-	-	3
Borreria ocymoides, H	-	-	-	-	10	-	-	-	10
Gardenia terniflia, T	-	-	1	-	-	-	-	-	1
Sarcocephalus latifolius, S	-	-	2	-	1	-	-	-	3
Spermacoce ruelliae, H	80	4	100	-	-	-	30	-	214
Allophylus africanus, T	-	-	-	-	-	-	-	10	10
Sterculia setigera, T	-	1	-	-	-	-	-	2	3
Watheria indica, H	60	-	-	3	-	-	-	-	63
Triumfetta rhombodea, H	-	20	-	-	-	-	-	-	20
Triumfetta tomentosa, H	-	-	-	-	-	4	-	-	4
Clerodendrum capitatum, WC	-	-	-	-	-	-	-	20	20
Lippa mutifloar, WH	-	2	-	-	-	-	-	-	2
Vitex doniana, T	1	-	-	-	-	-	-	-	1
Cissus ibuensis, C	-	2	-	-	-	-	-	-	2
Cissus populnea, WC	-	-	-	1	-	-	-	-	1
Cissus rufescens, WC	-	-	100	2	-	-	2	10	114
Scadoxus multiflorus, H	-	-	30	-	20	-	-	-	50
Anchomanes difformis, H	-	-	-	-	-	-	-	10	10
Commelina henahalensis,	2	-	-	2	-	-	-	300	304
Cyperus dilatatus, H	90	-	-	-	10	-	-	-	100
Mariscus alternifolius, H	-	4	-	5	-	-	-	-	90
Dioscorea bulbifera, H	-	-	-	-	-	-	-	10	10
Dioscorea dumentorum, H	-	1	-	-	-	-	-	4	5
Acroceras zizanioides, H	-	-	-	-	-	-	-	100	100
Andropogon gayanus, H	-	-	-	80	-	-	-	-	80
Digitaria horizontalis, H	200	-	-	-	-	100	-	-	300
Imperata cylindrical, H	-	100	-	100	400	-	-	-	600
Rottbellia cochinchinensis, H	100	300	300	100	300	200	-	10	1310
Setaria barbata, H	200	-	-	40	-	100	-	-	340
Setaria anceps,	-	300	100	100	200	200	300	-	1200
Sorghum bicolor, H	-	-	-	-	4	-	-	-	4
Viteveria fluvibarbis, H	-	-	-	-	-	100	-	-	100
Tacca involucrate, H	-	1	-	2	-	2	1	1	7
Daniellia oliveri, T	25	1	-	2	-	-	-	-	28
Byrsocarpus coccineus, H	60	-	-	-	-	-	-	-	60
Total									7303

Note: T-Trees, H- Herbs, S- Shrubs, WC- Woody Climber, WH- Woody Herbs

Table 2 : Medicinal plants in study area

Botanical name	Vernacular name (Tiv)	Plant part used	Cure
Ageratum conyzoides	Ngo-kwase	Whole plant ground and applied on affected area.	Body swelling
Strychonos spinosa	Maku	Fresh leaves squeezed	Blood clotting
Hyptis spigera	Eem	Squeezed leaves inhaled	Headache
Laggera aurita	Ijondugh	Squeeze leaves and rub	Rheumatism
Trema orientalis	Chiese	Bath with whole plant boiled	Small pox
Chromolenea odorata	Gbokpai	Whole plant steamed and inhaled	Fever
Coclospermum linktorum	Kpavande	Make a solution of ground roots	Yellow fever and Typhoid
Parkia biglobosa	Nune	Grind bark	Diarrhoea
Cassia spectablis	Ngaji	Boiled roots and drink	Yellow fever
Hymenocardia acida	Iikwar	Boil leaves/stem, drink	Stomach ache
Boerhavia repens	Mgbera-yongo	Grind underground bulb, eat	Stomach ache, penis erection
Elusine indica *Tylophora systrica*	Kangeraka	Grind whole plant	Dislocation, cuts
Khaya senegalensis	Haa	Squeeze leaves, rub	Headache
Byrsocarpus coccineus	Hwer-baa	Grind leaves	Waist pain
Anona senegalensis	Ahur	Boil whole plant	Reptile & sake bite
Pandiaka inolucrata	Ahambe-akwator	Squeeze whole plant	Catarrh
Azadirachta indica	Dogonyaro	Boil leaves	Fever
Bridelia ferruginea	Ikpine	Boil leaves, bark and root	Hepatitis
Hyptis suaveolens	Human	Boil whole plant	Mosquito
Vitellaria paradoxa	Chamegh	Seed oil	Repellant relaxer
Lonchocopus laxiflorus	Gbagbongum	Ground leaves and stem	Rheumatism
Prosopis africana	Gbaaye	Ground bark	Skin burn
Syzygium guineense	Alom	Boil root	Hernia
Parinari polyora	Ibua	Boil root, leaves, and bark	Stomach and tooth ache

Triculia emetica	Gbur	Boil root	Snake bite
Imperata cylindrica	Ihila	Boil root	Worm infection
Sarcocephalus latifolius	Ikura	Cold bath with ground leaves	Measles
Stereospermum kunthianum	Anema-atumba	Cut stem in water	Stomach ache
Uraria picta	Gyaase	Ground leaves	Heart burn
Cynastrum nodiflora	Mondu-kunankwa	Ground bulb, rub	Skin burn
Vernonia amygdalina	Ituna	Squeeze whole plant, drink	Fever
Pericopsis laxiflora	Giragba	Boil root,drink	Stimulant
Daniela oliveri	Chiha	Ground tender leaves,drink	Diarrheoa
Ipomia batatas	Atsaka	Soak whole plant	Anemia
Piliostigna thonningi	Nyihar	Boil whole plant	Stomach ache
Cissus ibuesis	Dedooko	Boil whole plant	Stomach ache
Ficis sur	Tur	Soak bark	Diarrhea
Cissus refescens	Ikpoor	Ground bulb	Stomach ache
Psedocedrela kotchyi	Kpamegh	Boil bark	HIV/AIDS

Table 3: Edible plants in study area

Botanical nam e	Vernacular nam e (Tiv)	Part(s) eaten	Traditional food type
M oringa oleifera	Jeglegede	Flowers, leaves	Vegetable
Ficur sur	Tur	Tender leaves, ripe fruits	Vegetable , fruit pulp
Tecca leoutopetaloides	Gbache	Underground bulb	Soup
Physalis angulata	Tam kpur	Ripe fruits	Fruit pulp
Grewia venusta	Hwer	Stem fibre	Soup
Vitex doniana	Hulugh	Fruits	Fruit pulp
Elaeis guineensis	Ikye	Fruit,palm wine	Oil, drink
Imperata cylindrica	Ihila	Root rhizom e	Sweetener
Parinari polyandra	Ibua	Fruits	Fruit pulp
Hibiscus aspera	Agakpande	Fresh leaves	Leafy vegetable
Prosopis africana	Gbaaye	Seeds	Condim ent
Dioscorea rotundata	Yough	Roots	Pounded yam
Vetellaria paradoxa	Cham egh	Ripe fruits	Fruit pulp
Anona senegalensis	Ahur	Ripe fruits	Fruit pulp
Bombax costatum	Kuka	Dry leaves	Vegetables
Parkia biglobosa	Nune	Ripe fruits	Condim ent
Cisus polnea	Ager	Fibre	Soup
Strychonos spinosa	M aku	Ripe fruits	Fruit pulp

Table 4 : Fauna species in the study area

Scientific name	Family name	Common name	Vernacular name
Lepus capensis	Hyracoidean	Rabbit	Alom
Xerus erythropus	Rodentia	Ground squirrel	Hinga
Cricetomys gambianus	Rodentia	Giant rat	Ikyoor
Thryonomis swinderianus	Rodentia	Cane rat	Viha
Myomys daltoni	Rodentia	Bush mouse	Mchoko/ Akpev
Chephalophus rufilatus	Artiodactyla	Red flanked duiker	Ikyuran
Qurebia ourebi	Artiodactyla	Oribi	Ihoh
Genetta tigtina	Carnivora	Bush genet	Ishumbe
Alcedo quadribrachys	Akedinidae	Shining blue king fisher	Ayoosu
Ardeola ibis	Arideidae	Cattle egret	Inyon-bua
Aremopterix leucotis	Alaudidae	Hawk	Itsoo
Tockus nasa	Bucerotidae	Grey hornbill	Ichaankera
Arvicanthis niloticus	Cricetidae	Nile rat	Iyonguv
Clarias gariepinus	Clariidae	Mud fish	Gbaver
Clarias anguillaris	Clariidae	Mud fish	Ashoon
Oreochromis niloticus	Cichlidae	Tilapia	Ikpuo
Barbus occidentalis	Bagridae	Cat fish	Ambi-uya

Table 5: Results of Presumptive Test (Using Mccradys Statistics Table)

Location of sample	Description	Number/100ml of water	Number/100ml of water	Number/100ml of water
		Coliforms	Faecal coliforms	Colonies/plate
A	(Upper part of the River)	350	45	2.36 x 10^5cfu/ml
B	Opposite A	550	60	2.31x 10^5cfu/ml
C	(Middle)	200	45	1.29 x10^5cfu/ml
D	(lower part of River)	550	170	2.40 x 10^5cfu/ml
E	(Opposite D)	900	275	2.30 x 10^5cfu/ml

Table 6: Results of standard plate count from soil sample

Location of sample	Number of colonies per plate	Number of colonies per plate	Number of colonies per plate	Number of colonies per plate
	10^{-1}	10^{-2}	10^{-3}	10^{-4}
Point I	90	86	50	15
Point II	180	162	80	30
Point III	85	50	42	22
Breath I	91	78	38	20
Breath II	81	55	25	18
Breath III	87	63	31	15
Length I	89	70	43	20
Length II	195	98	60	29
Length III	108	93	65	40
Reference point				
Eco Control I	80	50	41	22
Eco Control II	250	120	70	40
Eco Control III	48	30	20	07
Eco Control IV	Too crowded	160	85	60
Plot I within site	Too crowded	170	91	70
Plot II within site	200	108	70	50
Plot III within site	80	41	30	20

DISCUSSION

Species inventory, abundance and distribution

A total of 77 plant species were identified. Of this, 23 species were trees, 6 shrubs, 34 herbs, 3 woody climbers, 3 climbers while woody herbs, bryophytes, mushrooms and lichens had two species each. The results show that herbs were more abundant than trees and shrubs. This is a physiognomic feature of the guinea savanna zone where Makurdi is located. Seven families were outstandingly abundant. These include Poaceae (9 species) followed by Fabaccae (8 species) and

Euphorbiacaee (6 species). Combretaceae, Compositae and Meliaceae had four species each. The most dominant species were *Rottboellia cochinchinensis, Sateria ancepts* and *Tephrosia bracteolate* with 1310, 1200 and 760 species respectively. Information from interviews with hunters and fishermen in the neighboring community reveals that 12 families of animals made up of 4 species of Rodentia and 2 species of Artiodactyla while Carnivora, Cricetidae and Akedinidae had one species each as shown in Table 4. Others were four fish species in 3 families made up of Clariidae (2 species) and Chichlidae with Bagridae having one species each. Six tree species *Lannea schimperi, Stereospermum kunthianum, Euphorbia heterophylla, Hymenocardia acida Trichilia emetic* and *Vitex doniana* were found only within the facility with none seen within the control plots.

MEDICINAL PLANTS

Forty-one (41) plants were identified to have medicinal importance in the study area. The ailments reported to have been cured by these plants range from headaches, fever, waist pain, stomach ache, rheumatism, hernia, snake bites, catarrh, small pox, blood clotting and hepatitis among others as shown in Table 2. Although these claims have not being verified, the people affirmed that for decades, they have being using the plants successfully for the treatment of the said ailments as passed unto them by their fore- fathers.

EDIBLE PLANTS

18 plants species in the area are eaten by the people mostly as vegetables, fruits and condiments (Table 3). *Moringa oleifera, Ficus sur, Hibiscus aspera and Bombax costatum* are eaten as leafy vegetables while *Ficus sur, Physalis angulata, Vitex doniana, Parinari polyandra, Vitellaria paradoxa, Anona senegalensis, Bombax costatum and Parkia biglobosa* are eaten as fruits. Two species, Prosopis africana and Parkia biglobosa are eaten as soup condiments. It was observed that *Prosopis africana, Strychonos spinosus, Anona senegalensis* and *Vitellaria paradoxa* have both medicinal and food values as reported by Etkin and Ross, 1982 and Pieroni et *al*, 2005.

Microbial Evaluation of Soil and Water in the study area

The result of standard plate count from soil samples and presumptive tests are presented in Table 5 and 6. Differences in soil microbial load are a function of soil fertility resulting from decayed organic matter. The higher the soil microbial count, the more fertile the soil and consequently the higher its potential for higher agricultural productivity. Eco control II, plot I and plot III are located within the plains of Jamo stream. The microbial status of the water is an indication of polluted water.

Total coliforms ranged from 3.50×10^5 to 9.00×10^5 colony forming units (cfu/ml) while faecal coliforms ranged between 4.5×10^4 to 2.75×10^5 cfu/ml. These indicates high level of contamination of the water from animal and organic matter and can harbour human pathogenic microorganisms. The organisms identified include *Escherichia coli , Aerobalter aeroginesa, Faecal Streptococcus* and *Bacillus aureus.* Others were *Escherichia ferundii, Salmonella typhosa , Pseudomonas aerogenosa Aspergillus spp, Penicillium spp* and yeast.

CONCLUSION

The results of the study present the status of environmental components within the waste treatment facility and can be useful as baseline information for monitoring and evaluation of the effects of the facility on the environmental resources. Species found only within the facility needs to be monitored to ensure that they are not destroyed to prevent their extinction within the facility. Also, there is need to investigate the nutritional profiles and therapeutic values of the edible and medicinal plant species respectively so as to verify the claims of the local residents. The soil within the facility is fertile due to in soil microbial load and the water is highly contaminated and harbours some pathogenic organisms which can cause disease.

REFERENCES

Agishi, E.C (2004). Etulo, Idoma, Igede, Tiv and Hausa names of plants. AGITAB Publishers Ltd Makurdi Nigeria.

Arbonnier, M (2004). Trees, Shrubs and Lianas of West Tropical dry zones, CIRAD -MARGRAF -MNHN , 1-573pp

Balemie , K and Kebebew, (2006). Ethnobotanical study of wild edible plants in Derashe and Kucha Districts, South Ethiopia. Journal of Ethnobiology and Ethnomedicine 2(53)

Etkin N.L and Ross P.J(1982). Food as medicine and medicine as food: an adaptive framework for the interpretation of plant utilization among the Hausa of northern Nigeria. *Soc Sci Med.* **16**: 1559.

Harris, A.H.,Birch,P. and Palmer, J. (1996). Land restoration and rehabilitation. Principles and practice.addison Wesley Longman.Pp 1

Keay, R.W.J (1989). Trees of Nigeria. Vol II. Clarendon Press Oxford. Pp 476-507

Onyekwelu S.S.C and Okafor, J.C. (1979). Ordination of savannah woodland in Nigeria using woody herbaceous species. Vegetation 40(2):95-100

Oshode, A.O., Bakare, A.A., Efuntoye,M.O and Sowunmi, A.A (2008).Microbial characterization of leachate from municipal solid waste ladfills. *Journal of International research vol.2 No 4 Autumn Pp 391-400.*

Paul,E.A and Clark, F.E (1988). Soil microbiology and Biochemistry. Academic press, Incorporated New York. Pp 80-87.

Pieroni A, Nebel S, Santoro RF, Heinrich M (2005). Food for two seasons: Culinary uses of non-cultivated local vegetables and mushrooms in a south Italian village. *Int J Food Sci Nutr* 56:245