



## Plants as medicinal stressors, the case of depurative practices in Chazuta valley (Peruvian Amazonia)

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### ABSTRACT

**Ethnopharmacological relevance:** Depurative practices, based on taking emetic plants and the restriction of food intake, are very much used in the traditional medicine of Chazuta (Peruvian Amazon) not only to restore health but also to maintain it.

**Aim of the study:** To describe Chazuta's depurative practices, within a theoretical framework that involves the stress system and which defines the role played by the medicinal plants used as medicinal stressors. This biomedical model is more inclusive in relation to the variety of medicinal uses found for these practices.

**Material and methods:** The information was obtained in the valley of Chazuta from October 2004 to August 2005 through semi-structured interviews to the 6.3% of its rural adult population (i.e., 140 individuals, 75% belonging to the San Martin Quechua's ethnic group). Thereafter, results were analysed and confronted to the existing literature.

**Results:** Overall, 191 depurative practices were reported in Chazuta where 114 different plant species were recorded and identified. Depending on their level of severity and duration, depurative practices can be classified as mild or strict. The wide range of medicinal uses reported supports both the involvement of adaptive stress responses in depurative practices and the consideration of the plants employed in this practices as medicinal stressors.

**Conclusions:** By inducing moderate stress within safe levels, depurative practices in Chazuta could produce adaptive responses that would protect against the detrimental consequences of chronic stress and stress-related diseases. This hypothesis could help to understand the diversity of the medicinal uses recorded in the field. Thus, plant remedies used in these practices in Chazuta could be considered as "medicinal stressors" as through vomiting the necessary neuroendocrine stress activation would be produced. In addition, other bioactivities that plants may harbour could converge with the whole stress reactivity process.

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### 1. Introduction

The use of medicinal plants in Chazuta (Peruvian Amazon) has been the study subject of recent publications of our group (Sanz-Biset and Cañigueral, 2011; Sanz-Biset et al., 2009). A particular aspect highlighted by these works has been the wide use of plant remedies in what we have described as depurative practices.

We use the term depurative to differentiate a group of practices in Chazuta that locals considered to be medicinal because it prompted a general cleansing effect. This cleansing effect was believed to be induced first by the ingestion of medicinal plants with emetic effects (sometimes also being purgative and often considered with other various medicinal

effects) and second by reducing food intake. The local belief is that this depurative effect, whether induced by emetic medicinal plants and/or through calorie restriction, produces a "general cleansing" that enhances health broadly speaking.

It is not uncommon for depurative practices to be used for bodily purification or detoxification in complementary and alternative medicine (Kayne, 2009). Nowadays, in medicine the term depurative is mainly used in the clinical management of poisoning and around the concept of dialysis, the method that removes waste and excess water from the blood in renal failure. However, in ethnopharmacology, the term depurative is often used to indicate medicinal plants with effects such as diuretic, purgative, perspirative, choleric, cholagogue or emmenagogue. These have been reported in regions across the world among different historical periods (Gurib-Fakim, 2006).

Some depurative practices that we reported in Chazuta were employed against different ailments prevalent in the region.

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For some of those, we found some correlation in between the medicinal uses reported and the available bibliographic data on plant bioactivity or active compounds (Sanz-Biset and Cañigueral, 2011). In part, those results may explain the use of plants in some depurative practices due to plant activities such as anti-inflammatory and antimicrobial. Indeed, besides the emetic effect, local informants also considered many other medicinal effects for the plants employed in these practices. However, in many occasions depurative practices in Chazuta were generally employed to tone and strengthen the body.

When we faced these more unspecific medicinal uses, we found ourselves limited with the conventional approach of targeting precise biological activities or active compounds, as there this relationship became less clear. Therefore, we were led to consider other biomedical models that could explain the broad spectrum of the physiological effects reported.

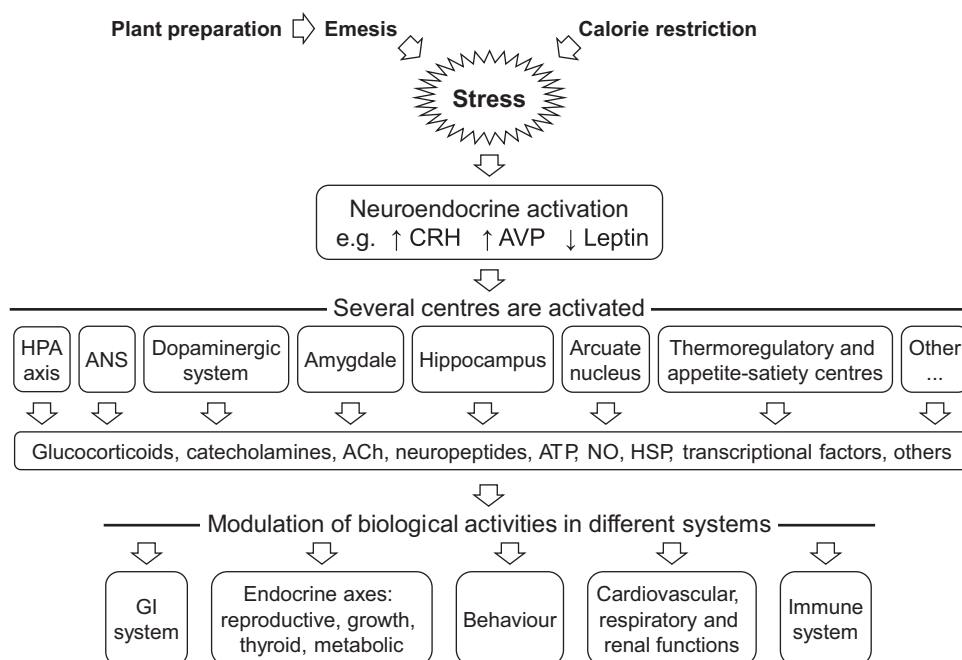
As a result, the explanation proposed here relates to the moderate activation of stress responses. The theoretical framework used to support these explanations is described in Appendix A (see the supplementary file). To sum up, it is known that both emesis and calorie restriction stimulate the neuroendocrine activation of the stress system (Eversmann et al., 1978; Masoro, 1998). As Chazuta's depurative practices mimic two very primitive and really stressful conditions that human beings can be encountered with, i.e., intoxication and starvation, it is feasible to consider the induction of moderate stress in a way that is medicinal. Considering models of beneficial exposure to stress is common in the study of physical exercise, diet restriction and other conditions (Jackson and Dishman, 2006; Sinclair, 2005; Tapia, 2006). Similarly to physical activity, depurative practices in Chazuta could elicit an adequate stimulation of the stress system, activating several centres such as the HPA axis, the autonomic nervous system and certain centres in the CNS. This activation could be within safe levels and could produce the corresponding adaptive responses conducive to beneficial stress resistance effects in different systems, e.g., gastrointestinal, endocrine, cardiovascular, respiratory or immune (Chrousos, 2006; Tsigos and Chrousos, 2002; Fig. 1).

Then, plant remedies used in depurative practices in Chazuta could be considered as “medicinal stressors” as through vomiting they could prompt the necessary stress to trigger adaptive stress responses. In addition, other bioactivities that plants are known to harbour could converge with the whole stress reactivity process.

The aim of this paper is to describe Chazuta's depurative practices within this more inclusive theoretical framework of adaptive stress responses that is able to indicate the biological processes that would explain the variety of medicinal uses found for these practices; and ultimately, to clarify the role that medicinal plants play in these practices as medicinal stressors. The present paper also brings data to the topic of plants and practices used for depuration, purification or detoxification. Even though this is a common subject in complementary and alternative medicine, papers rarely focus on it. Hence, ethnopharmacological data on this area is especially interesting and can prove to be useful in future studies.

## 2. Methods

The information collected in the field was obtained through semi-structured interviews to the 6.3% of the district's rural adult population (140 individuals, 60% men, 40% women, 75% of which was considered Quechua). The data presented in this paper is based in a wider fieldwork performed in the studied region from October 2004 to August 2005. In a previous published paper about the medicinal plants of Chazuta (Sanz-Biset et al., 2009), precise information was already given on the study site, its ethnicity, the demography, its socio cultural context, the historical background, the present medical system of Chazuta, how the selection of informants was done for the study, the type of interviews used, how plants were collected, which botanists participated in determining plant species, and how local consent for the investigation in Chazuta was obtained. Moreover, permit for the collection and exportation of voucher herbarium specimens was covered by official authorisations issued by the Agricultural Ministry of Peru's INRENA: Collection licence 087–2004-INRENA-IFFS-DCB and Exportation permit 005780-AG-INRENA.



**Fig. 1.** Neuroendocrine infrastructure triggered by stress which could be activated by depurative practices in Chazuta valley. ACh: acetylcholine, ANS: autonomic nervous system, ATP: adenosine triphosphate, AVP: arginine vasopressin, CRH: corticotropin-releasing hormone, GI: gastrointestinal, HPA: hypothalamic–pituitary–adrenal, HSP: heat-shock proteins, NO: nitric oxide.

Results obtained in the field were thereafter analysed and confronted to the existing literature.

### 3. Results and discussion

In this section, results are shown and discussed in the following sequence. First, quantitative results obtained in recording depurative practices in Chazuta valley are given. Then, depurative practices are described whether considered being mild or strict depending on their severity and duration. Also, the different medicinal uses reported are shown. Finally, the function of plants in depurative practices is discussed.

#### 3.1. Depurative practices reported in Chazuta

On the whole, 318 plant species used for medicinal purposes by people living in the Chazuta district were collected and identified. Of these, 114 species were found to be used in 191 depurative practices recorded in the survey.

Most of the plant remedies observed to be taken in depurative practices in Chazuta, were aqueous extracts, often unbearably bitter, highly unpleasant to drink, which seemed to act mainly as irritants of the gastric and intestinal mucosa triggering nausea conducive to emesis (Fig. 2).

The usual drastic vomiting caused by the herbal preparations administered in depurative practices in Chazuta, naturally brings the need to follow a more constrained food and behavioural regime (known as *dieta* in Chazuta). This can go from simply restricting some types of food, to becoming so strict that could



Fig. 2. The act of vomiting, which is highly regarded in the ethnomedicine of Chazuta valley.

even imply fasting. In the cases where fasting was present, salt limitation and rest in social seclusion was also prescribed.

Also, the use of emetic plants as well as the depurative practices themselves can be more or less prolonged in time. From having just a single cup of the squeezed juice of *Aristolochia leuconeura*'s leaves, to drink every morning for seven days a litre of a decoction made from *Tabernaemontana sananho*'s root barks. Also, the calorie restriction prescribed can be less-or-more severe and extended in time. Normally, the prolonged the emesis, the stronger the calorie restriction and the whole regime is. Due to their severity and length in time, depurative practices can be clearly classified either as mild or strict.

#### 3.2. Mild depurative practices.

These practices are characterised by a moderate calorie restriction that never reaches fasting, where neither seclusion nor the restriction of the ingestion of salt are prescribed. They are generally short in time, many lasting just one day where only a single dose of a plant remedy is taken. In total, we recorded 93 reports of mild depurative practices, which are shown in Table 1.

The remedy most reported (35 times) in these shorter depurative practices was the worldwide famous ayahuasca mixture, made with the decoction of *Banisteriopsis caapi* stems with *Psychotria viridis* leaves, and sometimes (16 reports) also adding other plant species. In comparison with other areas of the Peruvian Amazon, we observed that the traditional ingestion of these mixtures hardly entailed any complex ritual. As mentioned by Lamb (1985), it seems that even more than half a century ago, Chazuta's medicine men were not familiar with managing the psychotropic effects commonly experienced with ayahuasca. Nowadays, it is difficult to track the original use of ayahuasca since its tourist boom experienced in recent years has spread throughout the country. Even a bar recently opened in the valley was named as Ayahuasca, and there is a thriving tourist industry in the region based on offering ayahuasca trips into the jungle.

The use of ayahuasca that we reported in Chazuta, differs from what is shown in many other studies of other regions of western Amazonia (Baer, 1979; Cárdenas-Timoteo, 1989; Chaumeil, 1979; Fericglá, 1994; Luna, 1986). In Chazuta, it looks like as if this plant mixture has been included into the local repertoire of *purgas*. In a few occasions, we observed traditional healers giving out ayahuasca mixtures to patients. Except in those healers that had been already in contact with westerners that searched for "trips", the remedy was dispensed as another *purga* where the main goal was to produce that cleansing effect, i.e., the depurative effect. Thus, the healers did not expect any psychotropic effect rather than a simple *mareacion*, i.e., sickness conducive to vomiting. It is obvious that the international popularity of ayahuasca arrived years ago in this valley, however, and at least until recently, this trend seemed to have adapted and shaped quite well into the local traditional medical system, using ayahuasca more as a depurative than a psychotropic. Most likely, ayahuasca could have been introduced relatively recently in Chazuta's ethnomedicine and the high number of reports found explained by the external pressure. Acculturation in these regions advances fast and it is likely that such a fragile environment in front of such a strong western current would quickly put ordinary farmers into singing in the middle of the night in a high, wearing condor feathers and jaguar tooth, which sincerely, it is hard to say considering the first one original, which one of the three specimens is more extinct.

#### 3.3. Strict depurative practices

Strict depurative practices are characterised by a severe calorie restriction, usually leading to fasting. In these cases, both social

Table 1

Plant remedies used in mild depurative practices in Chazuta valley (Peruvian Amazon).

Scientific name (botanical family) (C = cultivated and/or W = wild) (voucher herbarium specimen)	Local name	Part(s) used	Unspecific use reports <sup>a</sup> N <sup>o</sup> :repeated reports <sup>a</sup>	Specific use reports N <sup>o</sup> :repeated reports	Mode of preparation (administration is oral)
<i>Ardisia guyanensis</i> (Aubl.) Mez (Myrsinaceae) (W) (BCN 40225)	Puka chakruna	Leaf	1	0	Decocted with <i>Banisteriopsis caapi</i> stems
<i>Aristolochia leuconeura</i> Linden (Aristolochiaceae) (C) (BCN 40090)	Yawar panka, Machakuy or Omagway waska, Wankawi sacha	Leaf	4	11 Cough (5), Bronchitis (5), Tobacco and cocaine addiction (1)	Squeezed, the juice obtained is drunk
			1	1 Tobacco and cocaine addiction. (1)	Decocted with <i>Banisteriopsis caapi</i> stems and <i>Psychotria viridis</i> leaves
<i>Banisteriopsis caapi</i> (Spruce ex Griseb.) C.V. Morton (Malpighiaceae) (C) (BCN 40135)	Ayawaska, Ayawaska negra, Ayawaska amarilla, Purgawaska	Stem	14	5 For hunting and fishing preparedness <sup>b</sup> (3), Stomach pains (2)	Decocted with <i>Psychotria viridis</i> leaves
			10+1*	0	Decocted: w/ <i>Ardisia guyanensis</i> leaves (1*), w/ <i>Psychotria alba</i> leaves (1), w/ <i>P. carthagenensis</i> leaves (1), w/ <i>P. ernestii</i> leaves (1), w/ <i>P. viridis</i> and <i>Gonzalagunia cornifolia</i> (2), w/ <i>P. viridis</i> and <i>Petiveria alliacea</i> (2), w/ <i>P. viridis</i> and <i>Pterocarpus rohrii</i> (2) w/ <i>P. viridis</i> , <i>Rosenbergiodendron longifolium</i> and <i>Toxosiphon trifoliatum</i> (1)
			1	1 Rheumatism (1)	Decocted with <i>Psychotria viridis</i> , <i>Mansoa alliacea</i> and <i>Piper callosum</i>
			1	1 Rheumatism (1)	Decocted w/ <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Licaria</i> sp., <i>Mikania</i> sp. and <i>Virola calophylla</i>
			1	1 Lumbago (1)	Decocted w/ <i>Psychotria viridis</i> , <i>P. alba</i> , <i>Brugmansia suaveolens</i> , <i>Calliandra angustifolia</i> , <i>Couroupita guianensis</i> , <i>Tovomita</i> aff. <i>stylosa</i> and <i>Zygia longifolia</i>
1*	1* Tobacco and cocaine addiction (1*)	Decocted with <i>Psychotria viridis</i> and <i>Aristolochia leuconeura</i>			
<i>Brugmansia suaveolens</i> (Humb. & Bonpl. ex Willd.) Bercht. & J. Presl (Solanaceae) (C) (BCN 40186)	Toe, Toe de flor blanca	Leaf	1*	1* Lumbago (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. alba</i> , <i>Calliandra angustifolia</i> , <i>Couroupita guianensis</i> , <i>Tovomita</i> aff. <i>stylosa</i> and <i>Zygia longifolia</i>
<i>Brunfelsia grandiflora</i> subsp. <i>grandiflora</i> (Solanaceae) (C) (BCN 40340)	Chirik sanango	Root bark	4	11 Febrifuge (7), For hunting and fishing preparedness <sup>b</sup> (4)	Macerated in fresh water for some minutes
<i>Calliandra angustifolia</i> Spruce ex Benth. (Fabaceae) (C) (BCN 40154)	Bobensana	Stem	1*	1* Lumbago (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. alba</i> , <i>Brugmansia suaveolens</i> , <i>Couroupita guianensis</i> , <i>Tovomita</i> aff. <i>stylosa</i> and <i>Zygia longifolia</i>
<i>Cornutia microcalycina</i> Pav. & Moldenke (Verbenaceae) (C and W) (BCN 40316)	Shinkurisacha	Leaf	1*	1* Rheumatism (1*)	Decocted w/ <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Licaria</i> sp., <i>Mikania</i> sp. and <i>Virola calophylla</i>
<i>Couroupita guianensis</i> Aubl. (Lecythidaceae) (C) (BCN 40136)	Aya uma	Bark	1*	1* Lumbago (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. alba</i> , <i>Brugmansia suaveolens</i> , <i>Calliandra angustifolia</i> , <i>Tovomita</i> aff. <i>stylosa</i> and <i>Zygia longifolia</i>
<i>Croton draconoides</i> Müll. Arg. (Euphorbiaceae) (W) (BCN 40216)	Sangre de grado	Bark	1*	1* Rheumatism (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Cornutia microcalycina</i> , <i>Himatanthus sucuuba</i> , <i>Licaria</i> sp., <i>Mikania</i> sp. and <i>Virola calophylla</i>
<i>Gonzalagunia cornifolia</i> (Kunth) Standl. (Rubiaceae) (W) (BCN 40275)	Pichana sacha, Pichana kaspi, Yaku lucero	Aerial part	2*	0	Decocted with <i>Banisteriopsis caapi</i> stems and <i>Psychotria viridis</i> leaves
<i>Guarea macrophylla</i> Vahl (Meliaceae) (C) (BCN 45069)	Requia	Bark	2	0	Decoction
<i>Himatanthus sucuuba</i> (Spruce ex Müll. Arg.) Woodson (Apocynaceae) (C) (BCN 40862)	Bellaco kaspi	Bark	2	2 Vermifuge (2)	Decoction
			1*	1* Rheumatism (1*)	Boiled with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Licaria</i> sp., <i>Mikania</i> sp. and <i>Virola calophylla</i>
<i>Hura crepitans</i> L. (Euphorbiaceae) (W) (BCN 40265)	Catahua	Latex	2	2 Vermifuge (2)	A small dose of the crude latex is drunk. This remedy is considered very toxic if overdose occurs.
<i>Jatropha curcas</i> L. (Euphorbiaceae) (C) (BCN 40263)	Piñon blanco	Leaf & seed	2	0	Squeezed, the juice obtained is drunk
<i>Jatropha gossypifolia</i> L. (Euphorbiaceae) (C) (BCN 40264)	Piñon colorado	Leaf & seed	2	0	Squeezed, the juice obtained is drunk
<i>Kalanchoe pinnata</i> (Lam.) Pers. (Crassulaceae) (W) (BCN 40358)	Rakta panka, Aire sacha	Leaf	1	1 Pain when passing water (1)	Squeezed, then a great quantity of the juice obtained needs to be taken



<b>Licaria sp.</b> (Lauraceae) (W) (BCN 40116)	Canela	Bark	1*	1*	Rheumatism (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Mikania sp.</i> and <i>Virola calophylla</i> Macerated in fresh water for some minutes
<b>Mansoa alliacea</b> (Lam.) A.H. Gentry (Bignoniaceae) (C and W) (BCN 40100)	Ajo sacha, Ajo sacha macho, Ajo sacha hembra	Stem and root bark	2	2	For hunting and fishing preparedness <sup>b</sup> (2)	
<b>Mikania sp.</b> (Asteraceae) (C)(JSB-513) <sup>c</sup>	Sinchi toe	Aerial part	1*	1*	Rheumatism (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> and <i>Piper callosum</i> leaves Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Licaria sp.</i> and <i>Virola calophylla</i> Decoction (in 3 reports), Macerated in fresh water for some minutes (in 2 reports)
<b>Minquartia guianensis</b> Aubl. (Olacaceae) (W) (BCN 40145)	Huacapú	Bark	5	0		
<b>Petiveria alliacea</b> L. (Phytolaccaceae) (C) (BCN 40892)	Mukura hembra, Mukura macho	Aerial part	2*	0		Decocted with <i>Banisteriopsis caapi</i> and <i>Psychotria viridis</i>
<b>Piper callosum</b> Ruiz & Pav. (Piperaceae) (C and W) (BCN 40846)	Guayusa macho or hembra	Leaf	1*	1*	Rheumatism (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> and <i>Mansoa alliacea</i>
<b>Psychotria alba</b> Ruiz & Pav. (Rubiaceae) (W) (BCN 40291)	Chakruna	Leaf	1*	0		Decocted with <i>Banisteriopsis caapi</i> stems
<b>Psychotria carthagenensis</b> Jacq. (Rubiaceae) (C and W) (BCN 40292)	Yaku bushiklla, Chakruna	Leaf	1*	0		Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>Brugmansia suaveolens</i> , <i>Calliandra angustifolia</i> , <i>Couroupita guianensis</i> , <i>Tovomita aff. stylosa</i> and <i>Zygia longifolia</i>
<b>Psychotria ernestii</b> K. Krause (Rubiaceae) (W) (BCN 40294)	Chakruna	Leaf	1*	0		Decocted with <i>Banisteriopsis caapi</i> stems
<b>Psychotria viridis</b> Ruiz & Pav. (Rubiaceae) (C) (BCN 40296)	Chakruna, Chakruna negra	Leaf	21*	5*	For hunting and fishing preparedness <sup>b</sup> (3*), Stomach pains (2*)	Decocted: w/ <i>Banisteriopsis caapi</i> (19*), w/ <i>B. caapi</i> & <i>Gonzalagunia cornifolia</i> (2*), w/ <i>B. caapi</i> & <i>Petiveria alliacea</i> (2*), w/ <i>B. caapi</i> & <i>Pterocarpus rohrii</i> (2*), w/ <i>B. caapi</i> , <i>Rosenbergiodendron longifolium</i> & <i>Toxosiphon trifoliatus</i> (1*) Decocted with <i>Banisteriopsis caapi</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Licaria sp.</i> , <i>Mikania sp.</i> , <i>Psychotria carthagenensis</i> and <i>Virola calophylla</i>
			1*	1*	Rheumatism (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Licaria sp.</i> , <i>Mikania sp.</i> , <i>Psychotria carthagenensis</i> and <i>Virola calophylla</i>
			1*	1*	Lumbago (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Mansoa alliacea</i> and <i>Piper callosum</i>
			1*	1*	Lumbago (1*)	Decocted with <i>Banisteriopsis caapi</i> , <i>Brugmansia suaveolens</i> , <i>Calliandra angustifolia</i> , <i>Couroupita guianensis</i> , <i>Psychotria alba</i> , <i>Tovomita aff. stylosa</i> and <i>Zygia longifolia</i>
			1*	1*	Tobacco & cocaine addiction (1*)	Decocted with <i>Banisteriopsis caapi</i> and <i>Aristolochia leuconorrea</i>
<b>Pterocarpus rohrii</b> Vahl (Fabaceae) (C) (BCN 40159)	Yawar kaspí	Bark	2*	0		Decocted with <i>Banisteriopsis caapi</i> stems and <i>Psychotria viridis</i> leaves
<b>Rosenbergiodendron longiflorum</b> (Ruiz & Pav.) Fagerl. (Rubiaceae) (W) (BCN 40304)	Lucero sacha	Whole plant	1*	0		Decocted with <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> and <i>Toxosiphon trifoliatus</i>
<b>Tovomita aff. stylosa</b> Hemsf. (Clusiaceae) (W) (BCN 44882)	Bachuja, Chullachaki kaspí/ hembra	Bark	1*	1*	Lumbago (1*)	Decocted w/ <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. alba</i> , <i>Brugmansia suaveolens</i> , <i>Calliandra angustifolia</i> , <i>Couroupita guianensis</i> & <i>Zygia longifolia</i>
<b>Toxosiphon trifoliatus</b> (Pilg.) Kallunki (Rutaceae)(W)(JSB-145) <sup>c</sup>	Lucero sisa, Lucero sacha	Whole plant	1*	0		Decocted w/ <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> & <i>Rosenbergiodendron longiflorum</i>
<b>Virola calophylla</b> (Spruce) Warb. (Myristicaceae) (W) (BCN 40115)	Cumala roja	Bark	1*	1*	Rheumatism (1*)	Decocted w/ <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. carthagenensis</i> , <i>Cornutia microcalycina</i> , <i>Croton draconoides</i> , <i>Himatanthus sucuuba</i> , <i>Licaria sp.</i> & <i>Mikania sp.</i>
<b>Zygia longifolia</b> (Humb. & Bonpl. ex Willd.) Britton & Rose (Fabaceae) (W) (BCN 44887)	Yaku or Untai shimbilla, Shimbilla	Bark	1*	1*	Lumbago (1*)	Decocted w/ <i>Banisteriopsis caapi</i> , <i>Psychotria viridis</i> , <i>P. alba</i> , <i>Brugmansia suaveolens</i> , <i>Calliandra angustifolia</i> , <i>Couroupita guianensis</i> & <i>Tovomita aff. Stylosa</i>

<sup>a</sup> Unspecific use reports were those which informants considered that the cleansing effect produced by depurative practices brought a general and unspecific tonic effects (see Table 3).

<sup>b</sup> In Chazuta, it was common to endure depurative practices to achieve the necessary fitness to go out in hunting and fishing expeditions. Moreover, through the depurative effect most of the corporal scent was expected to disappear, hence making human presence unnoticeable for wild animals which then become easier whether to hunt or fish.

<sup>c</sup> BCN codes unavailable. Instead, the collection number, i.e., **JsB-xxx**, is provided. If needed, a duplicate must be found in USM (Lima, Peru), where these specimens were yet to be entered.

**Table 2**  
Plant remedies used in strict depurative practices in Chazuta valley (Peruvian Amazon).

Scientific name (C=cultivated and/or W=wild) (voucher herbarium specimen)	Local name	Part used	Unspecific use reports <sup>a</sup> N <sup>o</sup> : repeated reports <sup>a</sup>	Specific use reports* N <sup>o</sup> : repeated reports	Mode of preparation (Administration is oral)
<i>Aspidosperma rigidum</i> Rusby (Apocynaceae) (W) (BCN 40686)	Tashkum remo kaspi, Remo kaspi	Bark	1	0	Decocted with the root bark of <i>Tabernaemontana undulata</i>
<i>Banisteriopsis caapi</i> (Spruce ex Griseb.) C. V. Morton (Malpighiaceae) (C) (BCN 40135)	Ayawaska negra, A. amarilla, Purgawaska	Stem	0	1	Pulmonary disease (1) Decocted with <i>Psychotria viridis</i> leaves
<i>Brosimum alicastrum</i> subsp. <i>bolivarense</i> (Pittier) C.C. Berg (Moraceae) (C and W) (BCN 40699)	Manchinga	Latex	0	3	Rheumatism (3) One spoonful of the latex is mixed with warm water
<i>Brunfelsia grandiflora</i> subsp. <i>grandiflora</i> (Solanaceae) (C) (BCN 40340)	Chirik sanango	Root bark	1	13	Rheumatism (12), Inguinal hernia <sup>b</sup> (1) Macerated in fresh water
<i>Callaeum antifebrile</i> (Griseb.) D. M. Johnson (Malpighiaceae) (C and W) (BCN 40246)	Shillinto blanco, Shillinto negro	Stem	1	4	Abscess (1), Leishmaniosis <sup>c</sup> (1), Tumors (1), AIDS (1) The crushed stem, (sometimes previously roasted), is macerated in fresh water. Normally, a single dose is given
<i>Calyptanthus bipennis</i> O. Berg (Myrtaceae) (C) (BCN 40119)	Guayusa macho Ullku guayusa	Leaf	1	0	Infusion
<i>Couepia chrysocalyx</i> (Poepp.) Benth. ex Hook. f. (Chrysobalanaceae) (W) (BCN 44897)	Parinari	Bark	0	1	Tumors (1) Decocted with <i>Remijia megistocaula</i> , <i>Smilax longifolia</i> and <i>Trichilia maynasiana</i>
<i>Esenbeckia amazonica</i> Kaastra (Rutaceae) (W) (BCN 40831)	Munichi sachá	Leaf	2	0	Decoction
<i>Ficus trigona</i> L.f. (Moraceae) (C and W) (BCN 40702)	Millwa renaquillo, Millwa renaco, M.r. macho, M.r. hembra, M.r. de hoja ancha, M.r. de hoja pequeña	Bark	1	0	Decoction
<i>Heliconia acuminata</i> Rich. (Heliconiaceae) (W) (BCN 40361)	Mishki panka	Leaf	0	1	For hunting and fishing preparedness <sup>d</sup> (1) Infusion, for drinking and, in addition, bathing
<i>Mansoa alliacea</i> (Lam.) A.H. Gentry (Bignoniaceae) (C and W) (BCN 40100)	Ajo sachá macho/ hembra	Stem and root bark	1	8	Rheumatism (8) Macerated in fresh water
<i>Maytenus</i> aff. <i>macrocarpa</i> (Ruiz & Pav.) Briq. (Celastraceae) (W) (BCN 40217/40218)	Chuchuwasha Chuchuwasha Blanca	Bark	0	2	Inguinal hernia <sup>b</sup> (1), Broken bones (1) Macerated in fresh water
<i>Phthirusa stelis</i> (L.) Kuijt (Loranthaceae) (C) (BCN 40133)	Suelda con suelda de hoja menuda, Pishku isman de hoja menuda	Stem	0	1	Inguinal hernia <sup>b</sup> (1) Decoction
<i>Physalis angulata</i> L. (Solanaceae) (W) (BCN 40877)	Bolsa mullaka	Whole plant	0	1	Malaria (1) Infusion
<i>Piper callosum</i> Ruiz & Pav. (Piperaceae) (C and W) (BCN 40846)	Guayusa macho, Guayusa hembra	Leaf	2	0	Infusion
<i>Poulsenia armata</i> (Miq.) Standl. (Moraceae) (W) (BCN 40578)	Yanchama blanca, Yanchama negra	Latex	0	1	Rheumatism (1) A few spoonfuls are mixed with warm water
<i>Psychotria viridis</i> Ruiz & Pav. (Rubiaceae) (C) (BCN 40296)	Chakruna, Chakruna negra	Leaf	0	1*	Pulmonary disease (1*) Decocted with crushed stems of <i>Banisteriopsis caapi</i>
<i>Remijia megistocaula</i> K. Krause (Rubiaceae) (W) (BCN 40270)	Capirona blanca	Bark	0	1*	Tumors (1*) Decocted with <i>Couepia chrysocalyx</i> , <i>Smilax longifolia</i> and <i>Trichilia maynasiana</i>
<i>Renalmia aromatica</i> (Aubl.) Griseb. (Zingiberaceae) (W) (BCN 40836)	Ñukñuk panka	Leaf	0	1	For hunting and fishing preparedness <sup>d</sup> (1) Infusion, for drinking and, in addition, bathing
<i>Smilax longifolia</i> Rich. (Smilacaceae) (W) (BCN 40850)	Zarza, Zarzaparrilla	Root	0	1*	Tumors (1*) Decocted with <i>Couepia chrysocalyx</i> , <i>Remijia megistocaula</i> and <i>Trichilia maynasiana</i> .
<i>Strychnos ramentifera</i> Ducke (Loganiaceae) (W) (USM 206354)	Suifa, Waska chuchuwasha	Stem	0	1	Malaria (1) Decoction

<b><i>Strychnos solimoesana</i></b> Krukoff (Loganiaceae) (W) (USM 206381)	Suifa, Waska chuchuwasha	Stem	0	1	Rheumatism (1)	Decoction
<b><i>Tabernaemontana sananho</i></b> Ruiz & Pav. (Apocynaceae) (C and W) (BCN40859)	Uchu sanango	Root bark	5	5	Rheumatism (3), Inguinal hernia <sup>b</sup> (1), Vermifuge (1)	Macerated in fresh water
<b><i>Tabernaemontana undulata</i></b> Vahl (Apocynaceae) (C and W) (BCN 40725)	Ushpawasha sanango, Ayac sanango	Root bark	1 1*	3 0	Rheumatism (2), Malaria (1)	Decocted or macerated in fresh water. Decocted with the bark of <i>Aspidosperma rigidum</i> .
<b><i>Tovomita brasiliensis</i></b> (Mart.) Walp. (Clusiaceae) (W) (BCN 45070)	Bachuja, Chullachaki kaspi, C. k. macho	Bark	0	1	Rheumatism (1)	Macerated with other plants to conform a particular Bachuja mixture <sup>e</sup> .
<b><i>Tovomita aff. stylosa</i></b> Hemsl. (Clusiaceae) (W) (BCN 44882)	Bachuja, Chullachaki kaspi, C. k. hembra	Bark	17	17	Rheumatism (7), Broken bones (5), Abscess (1), Inguinal hernia <sup>b</sup> (1), Leishmaniosis <sup>c</sup> (1), Vaginal pains (1), Urine infection (1)	Decocted (18) or macerated in fresh water (16), with other plants to conform the plant mixture known as Bachuja <sup>f</sup> .
<b><i>Trichilia maynasiana</i></b> C. DC. (Meliaceae) (W) (BCN 44884)	Shatunillu	Bark	0	1*	Tumors (1*)	Decocted with <i>Couepia chrysocalyx</i> , <i>Remijia megistocaula</i> and <i>Smilax longifolia</i> .

<sup>a</sup> Unspecific use reports were those which informants considered that the cleansing effect produced by depurative practices brought a general and unspecific tonic effect (see Table 3).

<sup>b</sup> We consider that the disorder known in Chazuta as *bajada de testos* (descendent testicles) refers to inguinal hernia. It is a much prevalent ailment among "Chazutian" men that is usually caused when carrying heavy weights.

<sup>c</sup> We consider that the disease known in Chazuta as *uta* refers to leishmaniosis. Even though it is rare in Chazuta, individuals who spend days deep inside the forest (normally involved in illegal tree felling) are especially prone to leishmania infection.

<sup>d</sup> In Chazuta, it was common to endure depurative practices to achieve the necessary fitness to go out in hunting and fishing expeditions. Moreover, through the depurative effect most of the corporal scent was expected to disappear, hence making human presence unnoticeable for wild animals which then become easier whether to hunt or fish.

<sup>e</sup> This particular Bachuja mixture is prepared by macerating the bark of *Tovomita brasiliensis* with the following plants: *Calliandra angustifolia* Spruce ex Benth. (Fabaceae) (BCN 40154) (1 report), *Clusia aff. palmicida* Rich. ex Planch. and Triana (Clusiaceae) (BCN 44874) (1), *Erythroxyllum* sp. (Erythroxyllaceae) (BCN 40234) (1), *Ficus nymphaeifolia* Mill. (Moraceae) (BCN 40638) (1), *Ficus vs. paraensis* (Miq.) Miq. (Moraceae) (BCN 40711) (1), *Ficus ypsilophlebia* Dugand (Moraceae) (BCN 40580) (1), *Tovomita cf. longifolia* (Rich.) Hochr. (Clusiaceae) (BCN 44878) (1) and *Zygia longifolia* (Humb. and Bonpl. ex Willd.) Britton and Rose (Fabaceae) (BCN 44887) (1).

<sup>f</sup> Bachuja mixtures are either macerations in fresh water or decoctions of *Tovomita aff. stylosa* bark with the following plants: *Tovomita foldatsii* Cuello (Clusiaceae) (BCN 44883) (29 reports), *Calliandra angustifolia* Spruce ex Benth. (Fabaceae) (BCN 40154) (20), *Maytenus aff. macrocarpa* (Ruiz & Pav.) Briq. (Celastraceae) (BCN 40217/40218) (13), *Zygia longifolia* (Humb. & Bonpl. ex Willd.) Britton & Rose (Fabaceae) (BCN 44887) (13), *Allosanthus trifoliolatus* Radlk. (Sapindaceae) (BCN 40140) (12), *Petrea* sp. (Verbenaceae) (BCN 40266) (12), *Clusia aff. lineata* (Benth.) Planch. & Triana (Clusiaceae) (BCN 44873) (10), *Dicranopygium aff. lugonis* Harling (Cyclanthaceae) (BCN 40083) (10), *Dicranopygium yacu-sisa* Harling (Cyclanthaceae) (BCN 40082) (10), *Rourea puberula* Baker (Connaraceae) (BCN 40691) (7), *Ficus trigona* L.f. (Moraceae) (BCN 40702) (6), *Clusia aff. lorentensis* Engl. (Clusiaceae) (BCN 44872) (4), *Salacia cordata* (Miers) Mennega (Celastraceae) (BCN 40566) (4), *Ficus caballina* Standl. (Moraceae) (BCN40710) (3), *Ruellia proxima* Lindau (Acanthaceae) (BCN 40220) (3), *Ardisia huallagae* Mez (Myrsinaceae) (BCN 40226) (2), *Clusia* sp.2. (Clusiaceae) (JSB24)<sup>g</sup> (2), *Clusia* sp.3. (Clusiaceae) (USM 207186) (2), *Clusia* sp.4. (Clusiaceae) (JSB-261)<sup>g</sup> (2), *Eugenia biflora* (L.) DC. (Myrtaceae) (BCN 40110) (2), *Ficus casapiensis* (Miq.) Miq. (Moraceae) (BCN 40647) (2), *Aspidosperma rigidum* Rusby (Apocynaceae) (BCN 40686) (1), *Asplundia* sp. (Cyclanthaceae) (JSB263)<sup>g</sup> (1), *Capparis sola* J.F. Macbr. (Capparaceae) (BCN 46106) (1), *Carpotroche aff. longifolia* (Poepp.) Benth. (Flacourtiaceae) (BCN 40258) (1), *Casearia* sp. (Flacourtiaceae) (BCN 40087) (1), *Chomelia paniculata* (Bartl. ex DC.) Steyer. (Rubiaceae) (BCN 40305) (1), *Chrysochlamys ulei* Engl. (Clusiaceae) (BCN 40227) (1), *Clusia aff. flavida* (Benth.) Pipoly (Clusiaceae) (BCN 45073) (1), *Clusia aff. palmicida* Rich. ex Planch. & Triana (Clusiaceae) (BCN 44874) (1), *Clusia* sp.1. (Clusiaceae) (JSB271)<sup>g</sup> (1), *Clusia* sp.5. (Clusiaceae) (JSB-469)<sup>g</sup> (1), *Condaminea corymbosa* (Ruiz & Pav.) DC. (Rubiaceae) (BCN40271) (1), *Copaifera paupera* (Herzog) Dwyer (Fabaceae) (BCN 40153) (1), *Coussarea brevicaulis* K. Krause (Rubiaceae) (BCN 40310) (1), *Dolioscarpus aff. dentatus* (Aubl.) Standl. (Dilleniaceae) (BCN 40192) (1), *Ficus americana* subsp. *guianensis* (Desv. ex Ham.) C.C. Berg (Moraceae) (USM 206345) (1), *Ficus eximia* Schott (Moraceae) (BCN 40697) (1), *Ficus macbridei* Standl. (Moraceae) (BCN 40696) (1), *Ficus vs. maxima* Mill. (Moraceae) (BCN 40639) (1), *Ficus obtusifolia* Kunth. (Moraceae) (BCN 208763) (1), *Ficus pertusa* L.f. (Moraceae) (BCN 40694) (1), *Ficus tonduzii* Standl. (Moraceae) (BCN 40648) (1), *Ficus ypsilophlebia* Dugand (Moraceae) (BCN 40580) (1), *Forsteronia graciloides* Woodson (Apocynaceae) (BCN 40684) (1), *Garcinia madruno* (Kunth) Hammel (Clusiaceae) (JSB-139)<sup>g</sup> (1), *Heteropsis flexuosa* (Kunth) G.S. Bunting (Araceae) (BCN 40328) (1), *Hevea guianensis* Aubl. (Euphorbiaceae) (BCN 40260) (1), *Hippotis tubiflora* Spruce ex K. Schum. (Rubiaceae) (BCN 40277) (1), *Inga ruiziana* G. Don (Fabaceae) (BCN 44889) (1), *Inga semialata* (Vell.) Mart. (Fabaceae) (BCN 44885) (1), *Marcgravia cf. crenata* Poepp. ex Wittm. (Marcgraviaceae) (JSB-250)<sup>g</sup> (1), *Mateleia rivularis* Woodson (Asclepiadaceae) (BCN 40332) (1), *Maxillaria* sp. (Orchidaceae) (JSB-159)<sup>g</sup> (1), *Phthirusa stelis* (L.) Kuijt (Loranthaceae) (BCN 40133) (1), *Psittacanthus cucullaris* (Lam.) Blume (Loranthaceae) (BCN 40313) (1), *Psychotria carthagenensis* Jacq. (Rubiaceae) (BCN 40292) (1), *Rinorea viridifolia* Rusby (Violaceae) (BCN 46108) (1), *Sida setosa* Mart. ex Colla (Malvaceae) (BCN 44891) (1), *Solanum monadelphum* Van Heurck & Müll. Arg. (Solanaceae) (JSB-259)<sup>g</sup> (1), *Strychnos ramentifera* Ducke (Loganiaceae) (USM 206354) (1), *Swartzia arborescens* (Aubl.) Pittier (Fabaceae) (BCN 40173) (1), *Swartzia simplex* (Sw.) Spreng. (Fabaceae) (W) (BCN 40172) (1), *Tovomita carinata* Eyma (Clusiaceae) (BCN 44877) (1), *Toxosiphon trifoliatus* (Pilg.) Kallunki (Rutaceae) (JSB-145)<sup>g</sup> (1) and *Unonopsis* sp. (Annonaceae) (W) (BCN 40720) (1).

<sup>g</sup> BCN and USM codes unavailable. Instead, the collection number, i.e., **jsb-xxx**, is provided. If needed, a duplicate must be found in USM (Lima, Peru), where these specimens were yet to be entered.

seclusion and the restriction of the ingestion of salt are often prescribed. They are longer in time than mild depurative practices and usually a plant remedy is ingested multiple times. For this second type of depurative practices, which are shown in Table 2, we obtained 98 reports.

These more severe depurative practices are known as strict diets and have been the study subject in a previous paper (Sanz-Biset and Cañigüeral, 2011). Informants stressed that the intention to take emetic remedies and to fast was again to produce this general cleansing effect considered medicinally beneficial by itself. It is common sense to see that the rejection of salt in such regimes may participate in the depurative effect as this restriction clearly enhances diuresis as well as other corporal secretions such as perspiration. The plant remedy known by informants as either *bachuja* or *mezcla de palos* was the most reported (34 times) in the survey for being taken in strict diets. It is a plant mixture that always contains species of the genus *Tovomita* (Clusiaceae) (Fig. 3) and which locals consider as the panacea of Chazuta.

#### 3.4. Uses of depurative practices and the function of plants

Depurative practices in the traditional medicine of Chazuta are used either to restore health or to maintain it. Even though we expected informants to bring in strong irrational beliefs to explain the function of their vomiting and starvation practices, the main argument they put forward persistently was the concept that cleansing, whether through emesis or by restricting food, was salutiferous. In addition, in Chazuta informants also stressed that if plants were to be used for curing, the necessary *dieta* was needed to be followed. In some occasions, fasting was said to be

the main cure and plant remedies just used to complement it. In a way, the fact that vomiting and starving was not avoided but desired, left us puzzled at the beginning, as it seemed to contradict our conventional western medical beliefs on health and healing.

Depurative practices reported in Chazuta were employed against different ailments prevalent in the region. The most common diseases in Chazuta have an infectious aetiology due to the tropical climate and lack of sewer systems. Musculoskeletal ailments are also frequent, due to the rural lifestyle. However, in many occasions depurative practices were employed to tone and strengthen the body, thus to cope better with the labour of being a *chacarero* (farmer), *montaraz* (hunter) and *mitayero* (rural worker in general). These terms partially compile the region's view of a capable, strong and healthy individual, i.e., someone able to sustain his/her family and clan, which until recently mainly depended upon the food harvested from the orchards, the animals hunted in the jungle and fished in the rivers, as well as upon the maintenance of a certain social balance (Salas-Fasabi, 2001; Weiss, 1949). It is considered that the cleansing produced by these practices brings a more general tonic effect expressed in Chazuta in ways such as: (a) augmenting work performance, (b) enhancing endurance (*hacerse más bizarro*), (c) increasing weight carrying, (d) extending cold resistance, (e) sharpening the senses, (f) lessening sluggishness (*dejar de ser arragán*), (g) preventing illnesses, or (h) improving sexual function.

The wide range of medicinal uses recorded for these practices, which can be separated as either being specific (103 reports) or unspecific (88), are shown in Table 3.

Determining the function of plants in depurative practices is less straightforward as, often, precise plant activities can not be



Fig. 3. *Tovomita* aff. *stylosa* with a single stilt root (left), and *Tovomita foldatsii* showing multiple stilt roots (right). Both are the plants most employed in the strict depurative practices in Chazuta valley.



**Table 3**  
Medicinal uses reported in the 191 depurative practices recorded in Chazuta valley (Peruvian Amazon).

Specific medicinal uses recorded (103 reports)	Unspecific medicinal uses recorded (88 reports)
Rheumatism (40 reports)	Depurative tonic
For hunting and fishing preparedness (11)	Cleansing tonic
Febrifuge (7), malaria (3)	Tonic
Broken bones (6), inguinal hernia (5)	To augment work performance
Cough (5), bronchitis (5)	To enhance endurance ( <i>hacerse más bizarro</i> )
Vermifuge (5), stomach pains (2)	To increase weight carrying
Tobacco and cocaine addiction (2)	To extend cold resistance
Abscesses (2), leishmaniasis (2)	To sharpen the senses
Tumors (2)	To lessen sluggishness ( <i>dejar de ser arragán</i> )
Urine infection (2), vaginal pains (1)	To prevent illnesses
Lumbago (1)	To improve sexual function
Pulmonary disease (1)	
AIDS (1)	

directly associated. In some cases plants are considered to play an important role in depurative practices used against specific ailments, mainly diseases where pain, inflammation and infection are present. Indeed, many plants employed in strict depurative practices are known to harbour activities such as anti-inflammatory and antimicrobial (Sanz-Biset and Cañigueral, 2011).

Nevertheless, the broadness of the use reports obtained is maintained in depurative practices—either these being mild or strict, either these using one plant remedy or another. Thus, once the depurative effect is induced, Chazutians expect this wide array of medicinal effects from it. A similar pattern applies for the plants employed in these practices, where the depuration considered to produce the broad spectrum of medicinal effects is fundamentally triggered by the stimulation of emesis.

The broadness of the use reports, the high number of unspecific uses reported and the fact that the induction of emesis is a common factor for the plants used suggest the involvement of adaptive stress responses in depurative practices and also support considering plants as medicinal stressors, that is, as inducers of beneficial levels of stress. Bearing in mind plants as medicinal stressors can lead to targeting different bioactivities.

In addition, a quick look at the plants mostly used in Chazuta's depurative practices clearly indicates the likely presence of CNS activity, especially in those plants belonging to the *Apocynaceae*, *Clusiaceae*, *Loganiaceae*, *Malpighiaceae*, *Solanaceae* and *Rubiaceae* families. Species of those botanical families were involved in 127 depurative practices reports (66% of all). It is clear that CNS activity could take part into the whole activation of the stress system. Also, a psychological aspect may contribute to the use of such drastic practices that depurations are. When the body is put under such pressure, whether through vomiting or starving, the state of the mind may be expected to follow a particular pattern where CNS plant activity may have its role.

#### 4. Conclusions

Overall, 191 depurative practices were reported in Chazuta using 114 different plant species which were recorded and identified. These practices can be classified as mild (93 reports) or strict (98) depending on how severe in restrictions and prolonged in time they are. By inducing moderate stress through emesis and calorie restriction and within safe levels, depurative practices in Chazuta could produce adaptive responses that would protect against the detrimental consequences of chronic stress and stress-related diseases. This hypothesis could help to understand the diversity of the medicinal uses that we recorded in the field, either specific (103 reports) or unspecific (88). The

experimental data shown in this paper supports considering plant remedies used in these practices in Chazuta as “medicinal stressors” as through vomiting the necessary neuroendocrine stress activation would be produced. In addition, CNS activity and other bioactivities that plants may harbour could converge with the whole stress reactivity process.

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#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.jep.2012.09.053>.

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