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Research paper

Preference and calorific value of fuelwood species in rural populations in northwestern Patagonia

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ABSTRACT

Traditional knowledge of fuel species was evaluated, associating species preferences with the physical properties of wood and its combustibility. The physical characteristics of 21 popular firewood species were analyzed in three rural communities in the northwest of Patagonia. Semi-structured interviews were carried out in 91 homes, as well as free listing and walks; samples of the woody species were collected in each of the homes visited. We have hypothesized that the experience of gathering and using fuelwood species, as cognitive know-how, over generations will have enabled local people to know species have best fuel attributes, such as hot coals, low spark and low smoke emission. Thus, for each sample, calorific value, density, moisture content and ash content were measured as predictive variables of combustibility. The fuel attributes of the different woods represent physical properties for which were analyzed by means of the classification for Fuel Value Index (FVI) priority species in the area. Results indicate that the species with the highest FVI values are those mostly preferred by local people such as *Berberis microphylla*, *Prosopis denudans*, *Schinus johnstonii*, *Lycium* spp., *Senecio subulatus* and *Schinus marchandii*. This work recommends the cultivation of energy crops of the preferred native species with high combustibility, to be used as bioenergy and multipurpose species.

1. Introduction

Wood can be used for different purposes, but the most extensive is as fuel in the world's rural communities which still depend on this energy source for heating their homes and cooking their food [1]. In general, human communities use and prefer local wood for fuel, that is, species native to their own area [2–4]. In the selection process carried out by local people, the attributes which characterize good fuel are inherent in each type of wood, established by the physical and chemical properties of each plant species [5]. Thus, certain physical properties of the wood are commonly valued by people for different activities [6–8].

The close relationship between local populations and their environment has been widely studied by the science of ethnoecology, which has been defined as the inter-disciplinary study of the knowledge systems, practices and beliefs of human groups relating to their environment [9,10]. One of the fundamental aspects of ethnoecology is the concept of interculturality, favoring dialogue between the academic realm and local wisdom. Current research, however, dealing with the importance of traditional knowledge and comparing it with empirical results shows that they have much in common [11].

Previous ethnobotanical investigations have focused on gathering and consumption patterns of fuelwood plants, such as how these gathering activities are distributed within the family [2,12,13], how plant gathering patterns change in hostile landscapes [14–19], what new practices are learnt in order to cope with wood resource shortage, for example the use of the byproducts of agricultural activities [20,21], which physical properties of fuelwood influence locals' preferences and the cultural significance of certain plant species [6,22,23].

For thousands of years the practice of gathering firewood has grown out of observation and experimentation with the qualitative and quantitative combustibility characteristics of woody resources [24]. Not all woods types are the same and therefore different attributes have conferred on certain species the character of a preferred resource in comparison with others. Amongst the qualitative characteristics that seem to be considered by different

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traditional societies are the duration of the hot coals, spark and smoke emission, and the biomass performance of the species. These attributes are important in the selection of species according to the daily tasks that must be carried out using fire [6,22,25,26]. Various academic studies have shown that certain quantitative characteristics such as calorific value, density, moisture content and ash content are determinant variables in combustibility [6,7,27]. Thus, to estimate the combustibility of a species, a formulas may be used which measure the previously mentioned quantitative variables by means of the Fuel Value Index [27].

According to [28], knowledge of the combustibility and physical properties of the woody species in a region is necessary for the programming of local management plans. In Patagonia (Argentina), the extraction of fuelwood from natural forests is a current practice, due to the permanent demand from the population who still depends on this resource [29]. However, extraction criteria and planning still do not take local valuation criteria into account, or combustibility values that are the scope of the present contribution. Legitimating local knowledge and practices might be a relevant way of increasing awareness and participation of locals in these environmental issues, which might contribute to the mitigation of the biomass loss. In Patagonia there are no studies that have measured the calorific value of native species or its association with local traditional knowledge, so the present investigation would be the first contribution on this matter.

In this work, therefore, we focus on studying the relationship that exists between the fuelwood species used in three rural communities in the northwest of Patagonia and their combustibility, integrating traditional knowledge with the physical properties of woody plants. In accordance with previous studies we expect to find that locals will prefer fuelwood species that will have high hot coal duration, low spark and smoke emission and the biomass performance of the species certain physical characteristics. We also hypothesize that the experience of gathering and using fuelwood of native species, as cognitive know-how, over generations will have enabled local people to know which species have best fuel attributes, and as a result, their preferred species will have the highest combustibility values. Therefore, we expect to find that locals will prefer plants with high Fuel Value Indices.

2. Methodology

2.1. Study area

The study area is located in the northwest of Patagonia, in the province of Rio Negro, Argentina. The work was carried out in three rural communities lying in the last foothills of the Andean Cordillera, west to east. This area includes the communities of Pilquiniyeu del Limay, Laguna Blanca and Comallo. The relief is marked by valleys, wetlands and rocky outcrops. Following the Köppen classification, the climate in these environments is an arid, steppe and cold (BSk) with annual precipitation of between 150 and 300 mm, concentrated in autumn and winter in the form of rain and snow, and the average annual temperature is 8 to 10 °C [30,31]. Additionally, to the west, there are adjacent temperate forests (Csb) and to the east, it borders the desert and cold Patagonian area (BWk) [31].

In Pilquiniyeu del Limay (40° 31′ S and 70° 02′ W; 898 m.a.s.l.) the landscape and vegetation take the forms of plant life predominant of shrubland, with microenvironments of *Larrea nitida*, *Colliguaja integerrima*, *Schinus* spp. and *Lycium* spp. The dwellings within the community are 10 and 20 km apart. The main economic activity is pastoral and agricultural. This community maintains its traditional leaders, the 'lonkos' who coexist with government authorities. The rural community of Laguna Blanca (40° 43′ S and 69° 50′ W; 1251 m.a.s.l.) and the semi-rural community of Comallo (41° 02′ S and 70° 16′ W; 782 m.a.s.l.) are both situated on the same road, at a distance of 70 km each.

The landscape around both communities is similar, the dominant vegetation being native grass species such as Pappostipa spp. and *Festuca pallescens and Festuca argentina*, as well as the growing shrubs *Mulinum spinosum*, *Senecio filaginoides*, *Senecio subulatus* and *Grindelia chiloensis* [32]. The closest urban center to these communities is the touristic city of San Carlos de Bariloche (150.000 inhabitants) at a distance of 220 km. In all cases, the families depend on fuelwood, mainly from their own surroundings, for cooking and heating their homes.

2.2. Methods

2.2.1. Field interviews

Semi-structured interviews, free listing and participant observation were carried out in order to study the use and the preferences of locals regarding domestic fuelwood biomass, and its role in family subsistence [25,26]. Informants named the preferred species which are 'good for firewood' and those which are non-preferred species but used. We inquire about the preference in the collection of woody fuels. The locals prefer the hardest species with longer duration of grilled who do too much sparkle; they do not burn quickly and hold heat. In each community previous consent was obtained for carrying out the work, and the basis for the work was explained to local authorities and all the visited local people.

In Pilquiniyeu del Limay a total of 28 families (total = 55) were interviewed; in Laguna Blanca 28 families (total = 45) and in Comallo 35 (only those who use firewood, total = 150). Questions were related to the use of plant species as domestic firewood and the characteristics which led to certain species being preferred. Walks were also carried out and inquiries made as to local people perception of the availability of fuelwood biomass in the area. Informants were interviewed between 2009 and 2011. A total of 91 families were visited, each one counting as a sample unit. Previous studies indicated that the three communities used a total richness of 26 species as firewood [25,26], 21 of them (17 species native to the region and 4 exotic trees) were included in this study. The 5 remaining species were not included in this study. These species are used little by locals as they are found a long distance away.

2.2.2. Sampling vegetation

The species selected for the physical analysis of the wood and the comparison of results with locals' preferences were most of the native shrubs and exotic trees used as firewood in each of the three communities [25,26]. The samples were all collected during the summer of 2012 in order to minimize variation of the variables to be measured. The samples were collected walking in a circle around the homes of Pilquiniyeu del Limay which are established in the town (40° 31′16″ S; 70° 02′ 36″ W) and the remaining homes which are distributed throughout different valleys on the reservation (e.g., 40° 26′ 59″ S, 70° 05′ 44″ W; 40° 29′ 58″ S, 70°01′ 23″ W; 40° 30′ 08″ S, 69° 53′ 28″ W; 40° 31′ 29″ S, 70° 05′ 59″ W; 40° 33′ 09″ S, 69° 57′ 03″ W and 40° 23′ 65″ S, 69° 56′ 23″ W). In Laguna Blanca and Comallo the collection was performed around the homes of the town with the geocoordinates described previously. For all samples the same collection methodology was used.

For the 21 species studied 17 shrubs and 4 trees. The height of the shrubs was between 0.5 (e.g. *S. filaginoides* or *G. chiloensis*) and 2 m (*Ochetophila trinervis*); all were adult plants. For each species, nine branches with bark (were obtained from 3 different specimens of green vegetation of similar sizes). The diameter of the samples collected varied between 0.5 and 2 cm, because they were adults with medium size. The branches collected were those located at the