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Wild mushroom potential in Ethiopia: An analysis based on supplier and consumer preferences

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Abstract

Aim of study: To elicit the preferences of the mushroom producers in rural areas and of the urban consumers in supermarkets. This allowed us to obtain key information to develop sustainable management and conservation plans in participation with local communities and to contribute assessing the potential economic value of wild mushroom resources.

Study area: Rural areas in the Amhara and Sidama regional states of Ethiopia, and in the capital, Addis Ababa.

Material and methods: A choice experiment following a D-0 design was performed to determine the preferences of the two main stakeholders: mushroom producers in rural areas and urban consumers in Addis Ababa supermarkets. Data were analyzed using a random parameters model. Willingness to pay (demand side) and willingness to accept (supply side) were calculated for different attributes.

Main results: The farmers are willing to be involved as a key participant in sustainable programs if they are compensated for their work in cash by long contracts; they prefer that the collection site is not very far their homes and to collect mushrooms in groups. If more time is spent walking from their homes to the forest, the compensation should increase. Urban consumers want to buy and pay for Ethiopian wild mushrooms and are interested in the sustainable production of mushrooms.

Research highlights: The farmers and consumers surveyed in this study recognized the potential of valuing mushroom resources as a potential way of conserving the forests where the mushrooms grow.

Additional key words: Africa; choice modeling; non-wood forest product; forest management; forest conservation

Abbreviations used: ASC (alternative specific constant); ETB (Ethiopian Birr, 1 Euro = 49.21 ETB [10th April 2021]; NWFP (non-wood forest product); WTA (willingness to accept); WTP (willingness to pay)

Authors' contributions: Conceived and designed the experiments, and analyzed the data: DA, MS. Performed the questionnaires: WT. All authors designed the questionnaires and wrote the paper.

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Introduction

The contribution of non-wood forest products (NWFPs) to the well-being of many rural and urban households around the world is well known (Mahonya *et al.,* 2019). Furthermore, many NWFPs are considered to have a high economic value, contributing to local and national economies in different countries (Angelsen *et al.,* 2014). For example, there is a growing industry under development to meet the European demand for products such as resins, tannins, berries and pine nuts, and wild mushrooms (Sheppard *et al.,* 2020). The highest proportion of value of sold NWFPs is made up of truffles, followed by forest nuts, berries and mushrooms (Lovrić *et al.,* 2020). However, the main stakeholders involved show a difference with respect to the production and use of these

resources. Rural people are predominantly collectors but they consume a smaller number of the resources compared to urbans (Lovrić *et al.,* 2021).

Interestingly, studies in different parts of the world have indicated that wild mushrooms can play key roles in local economic developments –in some cases, generating even greater economic benefits than timber production (Oria-De-Rueda *et al.,* 2008). There is a high demand of mushrooms as a wild edible food in different regions of the world (Boa, 2004) and, hence, they have long been collected generating cash income in market trades, as well as being used for local subsistence in food and as a traditional medicine (Boa, 2004; Chang & Lee, 2004). These practices can provide people in rural areas with a reliable income (Boa, 2004). If we put the focus on some African regions, the mushroom resource is somehow underutilized and its potential for feeding and providing income for Africa's growing population is neglected (Fernandes *et al.,* 2021).

In Ethiopia, mushrooms are wild edible resources and important NWFPs in some regions of the country and among different ethnic groups (Dejene *et al.,* 2017a). However, in Ethiopia, inconsistency between ethnic groups in terms of their knowledge and use of mushrooms exist, i.e. Amhara and Agew people are not used to consume the mushroom resource (Zeleke *et al.,* 2020). Furthermore, the potential of wild mushrooms resources has been largely neglected (Dejene *et al.,* 2017a,b) because forest resource management decisions have been primarily based on the production of wood products (Lemenih & Kassa, 2014). However, if managed and conserved properly, wild mushrooms could potentially enhance the livelihoods of rural people by providing a source of food and medicine, and a cash income. Moreover, some studies have reported that rural people in some localities are using wild mushrooms as a food source (Tuno, 2001; Muleta *et al.,* 2013) and as traditional medicines (Abate, 2014), highlighting the potential value of mushrooms and the need to invest some effort in determining the value of this resource in forest systems. Reconciling the social, economic and ecological values of the forests could encourage rural people to rationally manage and conserve forest resources in their locality. In order to influence the framework conditions that would make forest management and conservation efforts sustainable through the use of wild mushrooms, the monetary value of wild mushrooms need to be measured and quantified. Thus, policy makers could consider these benefits as part of their economic decision-making process.

Even though, mushroom resources are quite vulnerable to degradation when other forest products are collected, mainly fuelwood and timber products. For instance, in African miombo woodlands, where local communities collect mushrooms for consumption and trade, management practices should take mushroom production into account to prevent the degradation of the resource (Degreef *et al.,* 2020). The involvement of all stakeholders, from individual farmers to local and urban consumers, from local to international markets, is needed to develop forest conservation and sustainable management linked to forest food product valorization (Zocchi *et al.,* 2020). Thus, the voluntary contribution of local communities that depend on forests or that live close to forests is crucial to the implementation of sustainable forest management programs (Tadesse *et al.,* 2018; Gordillo *et al.,* 2019; Bamwesigye *et al.,* 2020), to obtain successful results and to enhance the conservation and management of forest resources (Temesgen, 2015). Furthermore, the social perception and value of natural resources are key information to consider when planning how to sustainably use and conserve these resources. Moreover, determining the value of natural resources would allow management plans to be designed that progress from sustainable use and conservation to economic benefit, which is essential for the involvement and well-being of populations that depend on forests (Amare *et al.,* 2016).

Valuation studies involve identifying the preferences of natural resource users. Understanding the preferences of producers and consumers is key to increasing the economic benefits of edible forest resources managed by local communities, which in turn contributes to the sustainable use and conservation of the forests (Agúndez *et al.,* 2018, 2020a,b). Moreover, Veljović & Krstić (2020) recommend determining values, motives, and attitudes that could increase the consumption and acceptance of mushroom-based products in emerging and growing markets. Thus, the aim of this study was to elicit the preferences of the two main stockholders: (i) the preferences of mushroom producers in rural areas in two Ethiopian regions, based on the compensation they could receive depending on the conditions for mushroom picking; and (ii) the preferences of urban consumers in supermarkets of Addis Ababa, based on their willingness to pay for the mushrooms depending on the different characteristics of the production

Material and methods

The supply side: Wild mushroom valuation by farmers

Area of study and characteristics of the sample

For the survey of rural respondents, we selected Injibara in the Amhara Region and Wondo Genet in the Sidama Region, following the criteria of a previous ethnomycological study (Zeleke *et al.,* 2020). Among others, the aim of the study was to record the use value of wild mushroom

species for each of the main ethnic groups living in the regions. They recognized 67 wild mushroom species after seeing photographic images (Zeleke *et al.,* 2020). The families with the greatest numbers of edible species identified were the *Agaricaceae* (13 species) and *Psathyrellaceae* (3 species). These two families represented 66.67% of the identified edible wild mushroom species in the area of study. People from both regions, have a very general knowledge about the mushrooms giving the same name to refer to several different species, mainly in Injibara. In consequence, we decided to refer generally to mushrooms in the questionnaire and choice experiment.

Geographical descriptions of the study areas are given in Table 1. Both regions are characterized by high-altitude natural forests (Friis *et al.,* 2010) and are dominated by Dry Afromontane forests. These forests are characterized by high humidity, a variable rainfall pattern and a prolonged dry season, making them complex and rich in biodiversity (Wassie *et al.,* 2005). The main tree species found in these forests are *Juniperus procera* (Hochst. Ex Endl.), *Podocarpus falcatus* (Thunb.) R. Br. ex Mirb., *Hagenia abyssinica* (J.F. Gmel.), and *Olea africana* subsp. cuspidata (Wall. & G.Don) Cif., which are the main sources of timber in Ethiopia (Kassa *et al.,* 2009). These Dry Afromontane forests also produce various types of NWFPs (Shumi, 2009), including edible fungi (Alem *et al.,* 2021; Dejene *et al.,* 2021).

Table 1. Geographical descriptions of the study areas

	Region	
	Amhara	**Sidama**
District	Injibara	Wondo Genet
Location	11°10′ N 36°15′E	7°060′ N 38°370′E
Altitude (m asl)	1870-2570	1760-1920
Mean annual rainfall (mm)	1300	1200
Mean annual temperature (°C)	18°C	19°C
References	Beza (2017)	Lulekal *et al.* (2011)

The Agew ethnic group occupies the center of the northern highlands of the Amhara Region, whereas the Sidama ethnic group inhabits the southern highlands. We assumed that both of the ethnic groups selected for this study use locally available NWFPs from their surrounding forests. In both cases, the farmers are sedentary farmers practicing mixed agriculture, including crop production and livestock rearing. However, the majority of the Sidama integrate cash crops, such as khat (*Catha edulis* (Vahl) Forssk. ex Endl.), sugar cane, and ensete (*Ensete ventricosum* (Welw.) Cheesman), and fish from the nearby lake.

The survey respondents were selected using a random sampling method, ensuring that at least 20% of respondents were female. Forty farmers living in dry Afromontane areas of the Amhara and Sidama administrative regions (Fig. 1) were surveyed.

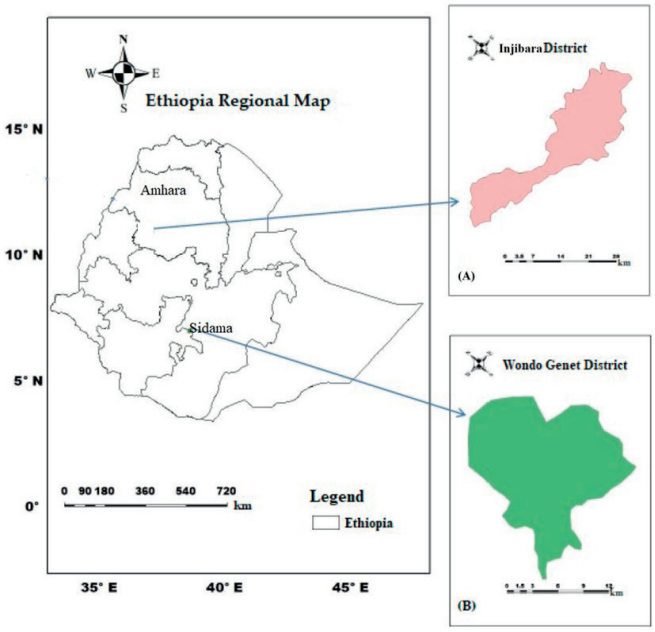

Figure 1. Ethiopia regional map. Location of the study districts in the Amhara Region and Sidama Region in Ethiopia: (A) Injibara district, which is inhabited by the Agew ethnic group and (B) Wondo Genet Woreda, which is inhabited by the Sidama ethnic group.

The questionnaire for wild mushroom production by farmers

A questionnaire comprising three sections was designed to assess the mushroom-picking preferences of farmers (see SM1 [suppl]). Section I was used to obtain information about the socioeconomics of the respondent. Section II was designed to assess their perception and knowledge of the forest's health status, resources and mushroom production. Section III comprised a choice experiment and some follow-up questions to determine the attributes that would be most important to farmers when deciding whether to participate in a mushroom-picking program. The first two sections of the questionnaire were completed first. Before starting the choice experiment, the overall aim of the program was explained as follows: *Different forest conservation programs based on the collection of mushrooms are being designed in your region. You have been randomly selected to participate in this study to help us to understand the preferences of the local people for these programs. Prior to the first collection, all participants (collectors) in this activity will be trained in topics related to: forest conservation;*

Table 2. Farmer's choice experiment: attributes and levels of mushroom collection

Attribute	Description	Levels
Collection context	Organization of collectors for mushroom picking	Individually or as part of a group
Number of mushroom-picking days per year	Total number of mandatory days for mushroom picking	10, 20, or 30 days per year
Maximum walking time to reach the forest for mushroom picking	Maximum time the collector would walk from home to reach the forest for mushroom picking	30, 60, or 90 minutes
Contract length	Period of time that the collector would be engaged in collecting mushrooms	2, 5, or 10 years
Compensation type	Compensation for mushroom picking in cash (ETB)[1] or in kind (in wheat and oil for food preparation).	Cash (ETB) or in kind
Compensation value per year and per collector	The total compensation (in cash or in kind)	300, 600, 900, or 1200 ETB

[1] ETB, Ethiopian Birr: 1 Euro = 49.21 ETB [10th April 2021].

sustainable practices for mushroom collection; mushroom identification to recognize poisonous mushrooms, edible mushrooms and mushrooms with medicinal and other properties; mushroom preservation; and the preparation and cooking of edible mushrooms.

After this short introduction, explanatory cards were used to explain each of the attributes considered in the choice experiment and their different levels to ensure the respondents understood the questions. A description of the attributes and levels is shown in Table 2, as well as the potential compensation in cash in Ethiopian Birr (ETB) or in kind for collecting mushrooms.

The choice experiment was designed following a D-0 design (Nordén *et al.,* 2017): 12 choice cards with four different options (three different programs with different attribute levels or the option of choosing none of them) were used to assess the respondents' preferences for different elements (attribute levels) of the mushroom-picking programs. A card is shown in Fig. S1 [suppl] as an example of the mushroom-picking options presented to respondents.

The demand side: consumer preferences

Forty customers were surveyed in five different branches (*i.e.,* C.M.C., Wossen, Cemiz, Century Mall and Megenegna) of Shoa supermarket located in Addis Ababa.

The questionnaire for wild mushroom consumption

The structured questionnaire was structured in three sections as the rural farmer's questionnaire (see SM2 [suppl]) but it was specifically designed to the consumers. Section I assess information about the surveyed consumer; section II about the consumer's perception of the forest's status and their knowledge of the value of mushrooms as marketable products; and Section III include the consumer choice experiment to determine which attributes were most important to consumers when deciding whether to purchase wild mushrooms and some follow-up questions. After completing the first two sections of the questionnaire, the overall aim of the program was explained as follows: *Mushrooms are fungi that provide several important nutrients and health benefits as they contain protein, vitamins, minerals, and antioxidants. Many types of mushrooms are fleshy and you can incorporate them into your diet. In Ethiopian urban markets, you can find fresh mushrooms cultivated in Ethiopia and cultivated mushrooms from foreign countries that are packaged in cans. In the next months, you will find a new product in this supermarket named "Enguday-Wild Mushrooms from Ethiopia" that has been collected by rural communities from Ethiopian forests. We would like to know about your preferences for some characteristics of "Enguday-Wild Mushrooms from Ethiopia". Now we will show you the details of the product and the related information that you will find included on the label.*

Then, an explanation was provided about the attributes and their levels with the help of explanatory cards. Table 3 shows the attributes and levels included on a hypothetical information label for Enguday, as well as the cost of Enguday (which means mushroom in Amharic).

The choice experiment comprised six cards with two different labels describing different elements (attribute levels) of the product. The respondent had to choose between three different options: two different labels describing different Enguday attribute levels and the option of choosing neither label. Card 5 is shown in Fig. S1 [suppl] as an example of the different Enguday attribute levels presented to customers.

Table 3. Customer's choice experiment: attributes and levels of the "Enguday-Wild Mushrooms from Ethiopia" product

Attribute	**Level**		
Type of producer	**National company**	**International company**	**Local cooperative**
Geographical origin (proximity to consumer)			
Sustainable forest management [1]	Yes 	No	
Fairtrade [2]	Yes 	No	
Price of a 200 g package of Enguday	60, 70, 80 ETB [3]		

[1] Forests where mushrooms are collected are under sustainable management preserving soil and mushrooms resources and forest biodiversity. Sustainability of forests is guaranteed when this logo is included in the label of the product. [2] Fairtrade certification guarantees fair prices, equity, dignity and decent work (forced labor and child labor are prohibited), etc. This certification includes requirements on democratic and participatory decision-making, transparency, and non-discrimination (including gender equity). Fairtrade is guaranteed when this logo is included in the label of the product. [3] ETB, Ethiopian Birr: 1 Euro = 49.21 ETB (10th April 2021).

Choice data analysis

Choice experiments can be a feasible approach when using very low sample sizes. Compared to other stated preference methods such as the contingent valuation method, each individual faces several choice tasks and a lot of information is generated. Sample size depends on the modeling approach, the number of attributes and levels, the complexity of the choices, the experimental design, etc. For example, Lancsar & Louvière (2008) argued that 20 respondents may be enough to estimate reliable models.

Choice data from each of the two sets of respondents were analyzed using a random parameters model (Train, 2009). Models were simulated using 500 replications with Halton draws, and normal distributions were assumed for all the attributes' coefficients. In order to estimate the consumers' willingness to pay (WTP, demand side) for Enguday and the farmers' willingness to accept (WTA, supply side) a role in the mushroom-picking program based on their preferences for different attributes of the choice experiment, we used the Krinsky & Robb (1986) parametric bootstrapping method with 1000 replications and a 95% confidence interval. NLOGIT® 6 software was used for simulations.

Results

Characteristics of the farmers, their resources and preferences

The 52.5% of the respondents were women and the 47.5% were men. The main ethnic groups which they belong were Sidama (45%) and Agew (45%) followed by Amhara (10%). The respondents were predominantly illiterate (37.5%) or had follow the primary school (32.5%), with an annual income of more than 36,000 ETB (40%) or between 6,001–12,000 ETB (25%). The mean age of far-

mers was 45 years (S.D. 13.68), 67.5% of them were head of the household. Most of them (97.5%) derived their income from cultivating the land and animal husbandry, suffering food shortages (52.5%) for on average 1.5 months a year (S.D. 0.51).

Most farmers (90%) collected NWFPs, with grass and firewood considered the most important. The forest was habitat in which mushrooms were most frequently found. The majority were not collecting mushrooms but 25% of the respondents, all of them in Wondo Genet. The respondents indicated that the main use of mushrooms was as food (32.5%). The perception the respondents had of the forest's health status is increasing (85%), decreasing (10%) and not changing (5%).

Table 4 shows the random parameters model used to estimate farmers' WTA based on different attributes of the choice experiment. On average, farmers preferred to be compensated for collecting mushrooms in cash, to have long contracts, to walk for some time from their homes to reach collecting sites and to collect mushrooms in groups. The number of collecting days per year was not a significant attribute when considering participation in a mushroom-picking program. Only one farmer (a man) did not select any of the program options in the choice experiment because he did not have any knowledge of mushroom picking. After the choice experiment, when farmers were asked what the most important benefit of the mushroom-picking program would be, they replied 'conserving the forest' (74.36% of respondents).

In both study regions, daily laborers work for between 8 and 11 hours a day, earning 150–200 ETB per day. The simulation analysis allowed us to infer the farmers' WTA one of the mushroom-picking options as part of the forest conservation program. In Fig. 2, we have simulated the farmers' WTA by attribute and considering any program *per se* (ASC) in ETB/year (median, interquartile range, atypical values, and extreme cases for all attributes and levels). Each participant would be willing to receive 7,014.43 ETB for collecting mushrooms for 30 days per year (234 ETB/day approx.) In addition, participants

Table 4. Random parameters model to estimate farmers' WTA and consumers' WTP based on the different attributes of the choice experiment (in ETB, Ethiopian Birr, 1 Euro = 49.21 ETB, 10th April 2021).

Attribute	Mean coefficient			S.D. of random parameters		
	Coefficient	S.E.	t-value	Coefficient	S.E.	t-value
			Farmers' WTA			
Collection context	9.543***	2.590	3.68	5.35543***	1.39455	3.84
Number of days	–0.028	0.032	–0.89	0.02803	0.11862	0.99
Walking time	0.030***	0.007	3.97	0.00647	0.10899	2.06
Contract length	0.319***	0.078	4.09	0.16729	0.06967	2.38
Compensation type	0.494**	0.202	2.44	0.17054	0.12739	0.73
ASC	4.764***	1.522	3.13			
Compensation	0.001**	<0.001	2.04			
Log likelihood	–193.110					
Restricted log likelihood	–664.035					
McFadden pseudo R-squared	0.709					
			Consumers' WTP			
National product	0.803**	0.359	2.23	0.00882	0.37740	0.02
Cooperative product	–0.618*	0.350	–1.76	0.52864**	0.26598	1.99
Distance	–0.001	0.001	–1.47	0.00206***	0.00071	2.92
Sustainable forest	2.149***	0.539	3.99	0.96961***	0.34177	2.84
Fairtrade	–.927	0.750	–1.24	0.78309**	0.35512	2.21
ASC	15.608***	4.308	3.62			
Cost	–.193***	0.053	–3.61			
Log likelihood	–178.572					
Restricted log likelihood	–262.568					
McFadden pseudo R-squared	0.320					

ASC: alternative specific constant. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

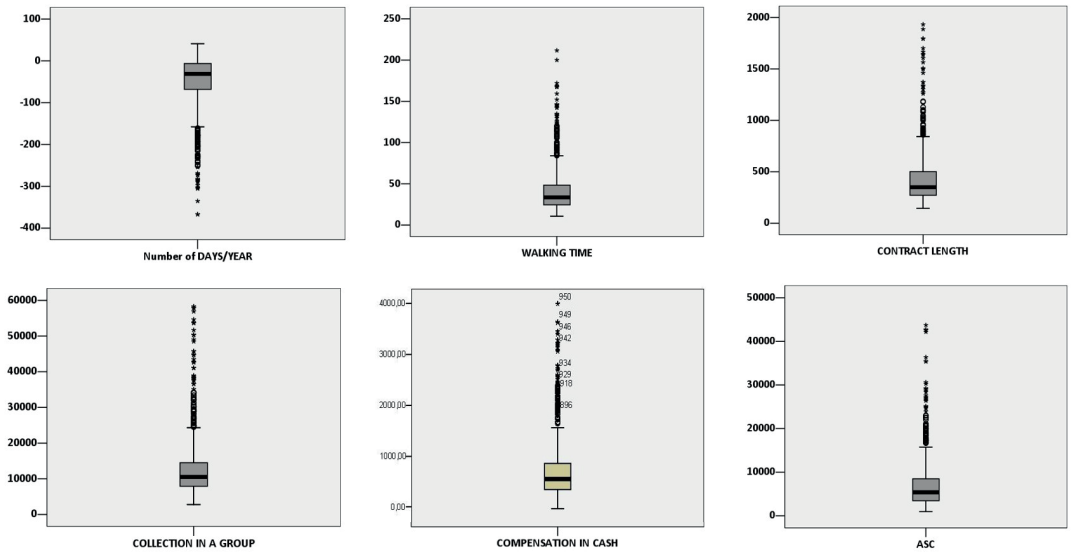

Figure 2. Simulation of farmers' WTA by attribute (the Y axis shows the median, interquartile range, atypical values, and extreme cases in ETB/year). ETB, Ethiopian Birr, 1 Euro = 49.21 ETB, [10th April 2021].

would require greater compensation for collecting mushrooms as part of a group (12,753.49 ETB/year), if more time is spent walking from their home to the forest (41.06 ETB/min spent walking to the collection site), for longer contracts (427.73 ETB/year) and if the compensation was in kind rather than a cash payment (706.52 ETB/year).

Characteristics of the urban consumer, their resources and preferences

Forty customers at five different branches of Shoa supermarket were interviewed when entering the supermarket. They were 62.5% of women and 37.5% of men. Most of them were Ethiopian (89.7%), followed by Eritrean (5%), Kenyan (2.5%) and Malawian (2.5%). Their marital status were predominantly married (70%). They had high education (University 47.5%, Diploma 15% and High School 12.5%). Their annual income was under 5000 ETB (35%), between 5001 and 10,000 ETB (20%), between 10,001 and 15,000 ETB (10%), between 15,001 and 20,000 ETB (17.5%) and more than 20,000 (17.5%).

The customers considered increased rainfall and microclimate amelioration to be the most important ecosystem services provided by forests. However, they also identified conservation of wildlife, biodiversity, soil and water, tourism and aesthetic value as services provided by forests. The perception they had about the status of forest resources was increased (10%), decreased (65%), not changing (7.5%) and did not know (15.0%). In total, 75% of respondents knew about mushrooms and considered their use as a food product to be the most important use, even though other uses were cited (*e.g.,* medicinal, fiber, and market product). The respondents were not used to buying mushrooms; however, some of them bought mushrooms either occasionally (10%) or periodically, ranging from once a month to once a week (15%). Respondents that buy mushroom products buy them in either 400-g cans for 350 ETB or in 200-g cans for between 60 and 85 ETB, and their preferred mushroom product is always available. Mushrooms are mainly bought because of their nutritional value, health benefits and taste.

Table 4 shows the random parameters model used to estimate consumers' WTP based on different attributes of the choice experiment. Of the 38 respondents interested on mushrooms, eight then said they would never buy *"Enguday-Wild Mushrooms from Ethiopia";* the other respondents declared that the product had value as a way of improving household health and conserving the forest, as well as the value of the mushroom resource itself.

The simulation analysis allowed us to infer that consumers would be WTP 81.017 ETB for a 200-g can of *"Enguday-Wild Mushrooms from Ethiopia".* Figure 3 shows a simulation of the customer's WTP by attribute and for a 200-g can of Enguday without a label (ASC) in ETB (median, interquartile range, atypical values, and extreme cases for all attributes and levels). They would prefer Enguday to be produced in Ethiopia (+4.06 ETB) and collected from sustainably managed forests (+11.30 ETB). WTP would be reduced if the product was obtained from cooperatives (–3.09 ETB) or had a Fairtrade label (–4.33 ETB), and with increasing distance from the production center (–0.001 ETB/km).

Discussion

The farmers and consumers surveyed in this study recognized the potential of valuing mushroom resources as a potential way of conserving the forests where the

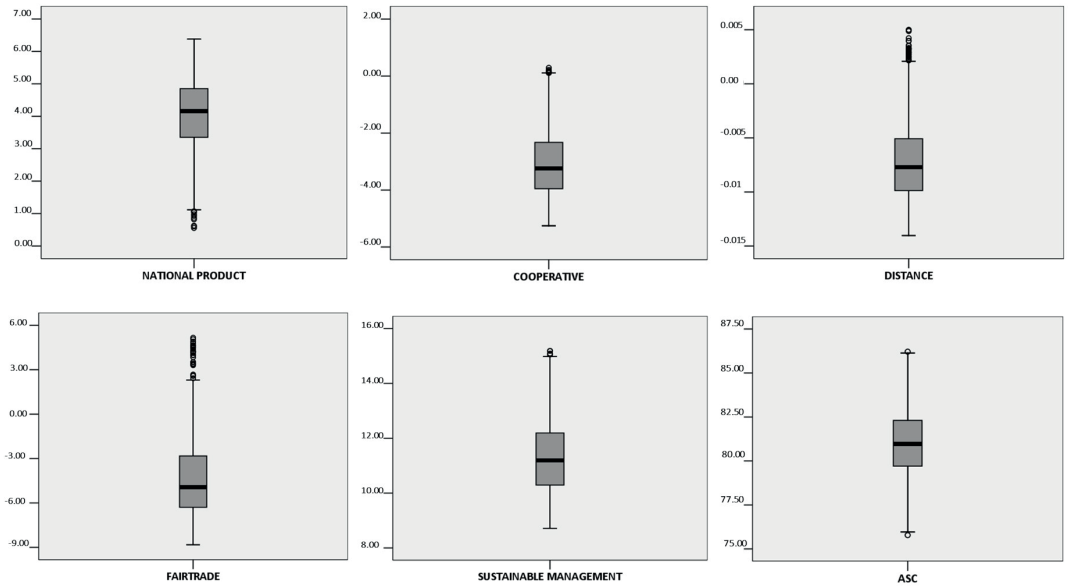

Figure 3. Simulation of customer's WTP by attribute (the Y axis shows the median, interquartile range, atypical values, and extreme cases in ETB/year). ETB, Ethiopian Birr, 1 Euro = 49.21 ETB, [10th April 2021].

mushrooms grow. The valuation, sustainable production, use and proper marketing of mushrooms could support the livelihoods of local communities while creating incentives for forest management. Furthermore, the increased perceived value of natural resources could reinforce the link between producers living around natural forests and consumers at local, regional and international markets (Tebkew *et al.,* 2018).

Landowner and consumer preferences for voluntary conservation schemes to protect natural resources depend on the economic situation of the region and the profitability of the resource (Lindhjem & Mitani, 2012; Kassahun *et al.,* 2020). However, if local communities have access to the forests, enabling them to exploit the forest's resources, they are not easily able to benefit in financial terms from the resources provided by the forest. Hence, there must be a financial incentive for local communities to conserve natural forests to ensure the sustainable provision of natural resources. Our surveys show that there are urban consumers who want to buy and pay for Ethiopian wild mushrooms and that farmers living in areas where wild mushrooms are produced are willing to collect them if they are compensated for doing this.

Our proposal is to compensate farmers for collecting mushrooms, a NWFP that is currently not valued, which has the potential benefit of reducing poverty in these areas. In Ethiopia, harvests of other NWFP such as gum and resin provide economic benefits for local populations that are in turn dependent on them. In collecting areas that allow free public access, the lower income population and women benefit from collecting and selling gum and resin (Abtew *et al.,* 2014). Our results differ with other valuation studies dealing also with compensation to the farmers when adhering to natural resources programs. Our surveys revealed that farmers collecting mushrooms prefer long contracts and payment in cash. By contrast, Haile *et al.* (2019) reported that in return for integrating *Faidherbia albida* trees into their smallholdings as part of an Ethiopian agroforestry scheme, farmers preferred short contracts and to receive lower annual payments if the compensation was in food rather than in cash. In our study, farmers would prefer to collect mushrooms in a group, whereas Ahiale (2020) found that WTA was reduced for collective actions when applying land conservation technologies.

The survey also revealed that customers are aware that mushrooms are beneficial for their health. Consumers broadly and more specifically in Africa and Ethiopia are demanding and willing to pay a price for healthy vegetables that are free of chemicals (Coulibaly *et al.,* 2011; Mengistie, 2020), and are positively influenced by the health and related nutritional labeling of different food products (Ahmed *et al.,* 2020; Chen *et al.,* 2020). In Ethiopia, the consumption of packaged foods is increasing, mainly in an urban context (Imiru, 2017). This has led to consumers becoming familiar with basic packaged-food labeling information (Tadesse *et al.,* 2020); however, more effort is needed to improve the information given about nutritional characteristics.

The consumer survey explored the knowledge, buying behavior and preferences of supermarket customers. Attributes directly related to ethical and respectful production by local populations and the conservation of natural forests were included. We found that customers were not interested in fair trade or local cooperative products. This may indicate that their impact on the wellbeing of the local populations that produce these products is not known in Ethiopia and that more information is needed (Ruggeri

et al., 2021) to raise awareness, as has been done in other countries (Maaya *et al.,* 2018). By contrast, consumers were interested in attributes related to sustainable management and how far away the mushrooms were sourced. The label designed for *"Enguday-Wild Mushrooms from Ethiopia"* is a sustainability label to inform consumers about the product's origin and production values.

Certification benefits all stakeholders in the supply chain, including central and local governments, producers and consumers. Sustainability certification labels or eco-labels have become a key method of providing consumers with information about food safety and health, as well as environmental preservation (Liu *et al.,* 2019). Certification schemes in forestry also have the potential to increase the appeal of NWFPs for consumers and, hence, provide a source of sustainable income for rural populations (Jo *et al.,* 2019). Further research is needed to better understand consumers' interest in sustainable mushroom production.

Our surveys has two main limitations in order to generalize the results to the diversity of ecological regions and ethnic groups of Ethiopia. Larger sample sizes are required to perform deeper heterogeneity analyses or to conduct post hoc analysis of social wellbeing. Besides the sample size, they were limited to the preferences of the two main stakeholder groups. Further studies are needed to investigate socioeconomics characteristics within these two groups as other related studies have reported that differences in gender, age group, household income, training and capacity building influence, and the willingness to contribute to conservation actions need to be considered when planning (Ahiale *et al.,* 2019; Alemu *et al.,* 2021). Moreover, access to extension services and to forest cooperative membership could have positive impacts on the level of participation as shown by Asfaw *et al.* (2018).

In summary, there are urban consumers who want to buy Ethiopian wild mushrooms. The farmers living in areas where wild mushrooms are produced are willing to collect them if they are compensated for doing this. The application of the baseline information presented in our paper could be used to design a program that brings together the production and marketing of wild mushrooms from Ethiopia's natural forests. Two main potential research areas have been identified: the influence of socioeconomic characteristics on producer and consumer preferences, and the certification of sustainable mushroom production. The methods and results could be used in other countries facing similar issues related to the use of mushrooms and forest conservation

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