



## **TITLE: Ecoproduction and potential of ora-pro-nóbis culture in the Paraíba do Sul River Valley in the State of São Paulo fertilized with biofertilizer from anaerobic and/or aerobic biodigesters treating residual biomass.**

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### **ABSTRACT**

The objective of this research was to collect online data on ecoproduction in the cultivation of 'ora-pro-nóbis' (OPN) fertilized with biofertilizer from anaerobic and aerobic biodigesters in the treatment of residual biomass in the Paraíba do Sul River Valley in the State of São Paulo in Brazil to support research planning and public policies. A questionnaire with 24 questions was created using a remote research management application and covered the cultivation, consumption, and commercialization of OPN. Applied to the agroecology group Rede Agroflorestal do Vale do Paraíba and food security group Roda de Saberes, made up of farmers, producers and rural owners, agriculture, health and education professionals, we obtained 52 completed questionnaires with OPN valued for its high protein and nutritional content, as a traditional food widely used by 96% of respondents who keep few plants in backyards and farms (82%) for the consumption of 0.5-1, 0kg of leaves per month in fresh form (29%), green juice (22%), cakes and breads (21%) and sautéed with meat (17%). Research should focus on pruning management (67%), necessary to maintain the low size of the plants and prevent the spikes from increasing in size as the branches age. This research provided a current overview of the growing popular interest in the consumption of OPN, which justifies investments to improve management and expand the scale of production to also serve the food and pharmaceutical industries.

### **BIOGRAPHY**

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## INTRODUCTION

The 'ora-pro-nóbis' (OPN) (*Pereskia aculeata* Miller) is a Non-Conventional Food Plant (PANC) of the Cactaceae family, native to South America and found in Brazil in the South, Southeast and Northeast regions of the country (KINUPP; LORENZI, 2014). Although there is no record of cultivars, Madeira et al. (2016) highlight morphological differences in OPN in relation to the color of the shoots (light green, dark green or pigmented, yellowish or reddish) and the shape of the leaves (variations in length, width and thickness). Furthermore, there are other edible species of the genus *Pereskia*, such as those illustrated in Figure 1, where (1) *P. aculeata* Miller. (white flower with orange center), (2) *P. bleo* (ora-pro- Amazon nobis with orange flower), (3) *P. grandiflora* (pink flower) and (4) *P. godseffiana* (yellowish leaves rich in beta-carotene with white flower and yellowish center) (adapted from KINUPP; LORENZI, 2014).

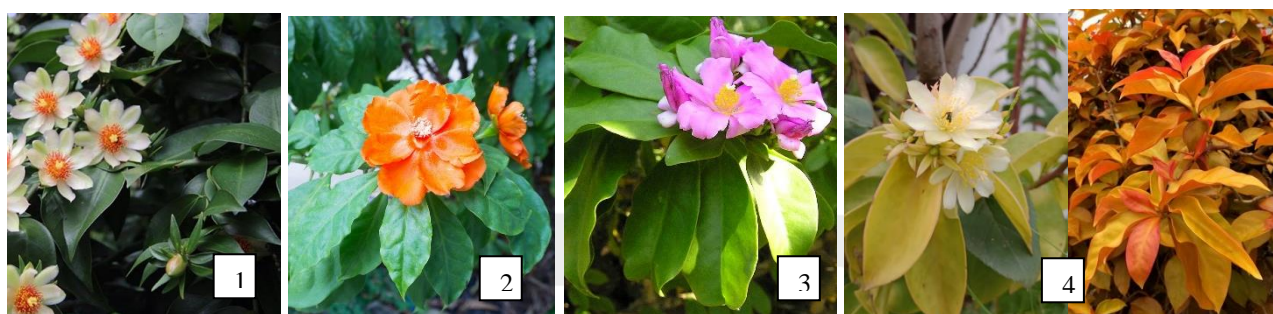


Figure 1 - (1) like *P. aculeata* Miller. (white flower with orange center), (2) *P. bleo* (Amazonian ora-pro-nóbis with orange flower), (3) *P. grandiflora* (pink flower) and (4) *P. godseffiana* (yellowish leaves rich in beta-carotene with white flower and yellowish center)

With the understanding of the important role of non-conventional food plants (PANC in the context of the worsening global climate and food crisis, a social movement seeks to rescue and popularize the diversity of neglected plants (KINUPP; LORENZI, 2014; CASTRO; DEVIDE, 2016). This is gaining more and more space at an international level (MARIUTTI et al., 2021), mainly because these plants are of great importance in dialogues on food and nutritional security and sovereignty (SEIFERT JUNIOR; DURIGON, 2021).

The appreciation of regional food culture with the rescue of PANC in Brazil brings a gain from a cultural, economic, social and environmental point of view (QUEIROZ, 2015; MADEIRA et al., 2016; DURIGON et al., 2023;). In Vale do Paraíba Paulista, after 10 years of research and technological dissemination of the cultivation and use of PANC, the organization of agroecology networks such as the Agroforestry Network of Vale do Paraíba and food security ROSA (Roda de Saberes em Alimentação Saudável), where actors participate and exchange knowledge, seedlings and seeds in workshops and field days (CASTRO; DEVIDE, 2016; CASTRO et al., 2021), there is a perception that the dissemination of information about the high protein content of OPN, between 16.6 % and 23.9% on a dry basis and as a source of essential amino acids (leucine, phenylalanine and lysine) (BOTREL et al., 2019), in addition to mucilage with beneficial properties used as a low-calorie emulsifier in the food industry (NOGUEIRA SILVA et al., 2023), increased interest in OPN.

The objective of this research was to verify the development of eco-production of cultivation and the consumption of OPN fertilized with biofertilizer from the treatment of residual biomass in anaerobic and aerobic biodigester systems in the Vale do Rio Paraíba do Sul region in the State of São Paulo in Brazil. This aims to improve knowledge about this species, support research planning and the structuring of public policies to encourage the creation of a regional production arrangement that addresses the preparation of family

farming to expand the scale of OPN production with the dissemination of strategies for adding value, in addition to raising market awareness about the consumption of this PANC. Figure 2 illustrates a schematic drawing of the treatment using an anaerobic biodigester system of residual biomass with its conversion into biogas fuel and biofertilizer for the agroforestry system with eco-production of ora-pro-nóbis.



Figure 2 - Schematic drawing of the treatment using an anaerobic biodigester system of residual biomass with its conversion into biogas fuel and biofertilizer for the agroforestry system with eco-production of ora-pro-nóbis.

## MATERIALS AND METHODS

This research is an initiative of APTA (Agência Paulista de Tecnologia dos Agribusinesses), through its Regional Research and Development Unit of Pindamonhangaba, within the scope of the Agroecology, Sovereignty and Food and Nutritional Security project and aims to collect information through an online questionnaire. line prepared on the virtual remote research management platform Google Forms. This method was chosen mainly because it enables popular participation, has a reduced cost and increases the speed of information collection and scientific production (FALEIROS et al., 2016).

The questionnaire was prepared with 24 questions, 16 closed and 8 open, which addressed knowledge about the respondents' profile, cultivation sites, management techniques, harvesting and consumption, processing and commercialization strategies, in addition to characterizing demands for improvement of the OPN's production arrangement. A link was generated on the virtual platform and forwarded to two telemessaging groups made up of people who have worked for more than 10 years on Agroecology and Food and Nutritional Security (SAN) projects.

The initial sample was 298 people, including family farmers, rural producers, technicians and academics who are part of the Vale do Paraíba Agroforestry Network, and 57 people who participate in ROSA - Roda de Saberes em Alimentação Saudável, composed of full-time mothers, retirees, public health students and professionals. 52 answered questionnaires from the initial sample were recognized, with the participation of 67% of members of the Agroforestry Network of Vale do Rio Paraíba do Sul linked to food production and 29% of people from the healthy eating study group (ROSA), in addition to 4% of people who were not part of any of the groups mentioned.

Information collection lasted 32 days (01/15 to 02/15/2023) and the data was systematized and analyzed based on the percentage of responses to the evaluated questions. An Informed Consent Form - ICF, in accordance with Resolution 466/2012, was previously presented, obtaining the consent of each participant for the development of the research and the use of the information.





## RESULTS AND DISCUSSION

The majority (96%) of the people who participated in this research already cultivate OPN in six municipalities (São Paulo, São José dos Campos, Taubaté, Tremembé, Pindamonhangaba and Cruzeiro) located on the BR-116 axis that connects São Paulo to Rio de Janeiro, Janeiro, and by three people from the interior of the Vale do Rio Paraíba do Sul in the State of São Paulo in Brazil (Lagoinha, São Luiz do Paraitinga and Natividade da Serra).

The OPN seedlings and cuttings for planting at VPP originated mainly from donations and exchanges between friends (64%) and the APTA/Regional Research Unit of Pindamonhangaba (31%). Thus, the actors in the conservation and dissemination of OPN in the region are the members of the Agroforestry Network who participate in participatory research activities at APTA on the cultivation and use of OPN, together with the active third sector that organizes seed and seedling exchange fairs. (5%).

The consolidation of eating habits in the Vale do Rio Paraíba Paulista do Sul in the State of São Paulo in Brazil is represented to this day in recipes that contain OPN, such as tropeiro beans, canjiquinha with OPN, free-range chicken, among other dishes. typical. Likewise, the OPN culture was established in several regions of Brazil, with emphasis on the states of Minas Gerais and Goiás, where social groups maintain the tradition of cultivation and still seek to overcome food insecurity through the consumption of OPN (MADEIRA et al., 2016).

The recognition of the importance of OPN for regional food security obtained in this research was in line with the results of other studies that found that this culture is highly valued with the growing popularization of socio-biodiversity in Brazil (KINUPP; LORENZI, 2014; CASTRO; DEVIDE, 2016; MADEIRA et al., 2016). Madriaga and Antunes (2023), through an online questionnaire applied to the general population, also found a great deal of control over the use of OPN as a food plant by 81% of people, without, however, understanding the meaning of the acronym PANC.

The concept of PANC only emerged in recent decades as a topic associated with food and nutritional security (CASEMIRO; VENDRAMINI, 2021). Its popularization is linked to initiatives for the rescue, conservation, production and diverse uses of PANC (KINUPP; LORENZI, 2014; CASEMIRO; VENDRAMINI, 2021). It is necessary to intensify the circulation of information with the public that produces and also consumes or is a potential consumer, to promote the inclusion of the use of OPN and other edible PANC in the population's diet.

Of all those interviewed, 52% defined themselves as occasional farmers (they plant for their own consumption), 23% are family farmers, 19% are others who grow crops at home, maintain a botanical garden for studies, are consumers or public health professionals who act as multipliers and 6% qualified as new rural as shown in Figure 3. The term new rural adopted in this research seeks to define the public that is returning to the countryside to produce and undertake in the midst of the agroecological transition guided by agroforestry systems (SAF), which seeks reconnection with the earth and develops other economic and holistic activities focused not only on production, but also on the mental and environmental health of the planet.

The majority of interviewees (82%) cultivate a few OPN plants (average two plants; deviation  $\pm 1.6$ ) in small productive backyards, on farms and farms for their own consumption; while 8.0% of respondents cultivate 10 plants and only 10% of respondents maintain more than 40 plants ( $\pm 19.0$ ) of OPN. The OPN culture is still little explored commercially (QUEIROZ et al., 2015), with the predominance in Brazil of cultivation as a domestic plant in small backyards to meet family needs without any commercial appeal (ZACHARIAS et al., 2021) and by some producers of seedlings (SILVA JÚNIOR et al., 2010). It is noted that in another survey, Madriaga and Antunes (2023) observed that only 35% of respondents cultivated OPN for self-consumption

and only three respondents carried out commercial activities with OPN, one of them being a family producer certified for organic management. Pereira et al. (2017), in a survey of backyards in the northern region of the Semiarid region of Minas Gerais, highlighted that traditional knowledge about the use and conservation of socio-biodiversity in backyards is strategic for maintaining the community's food security and sovereignty.

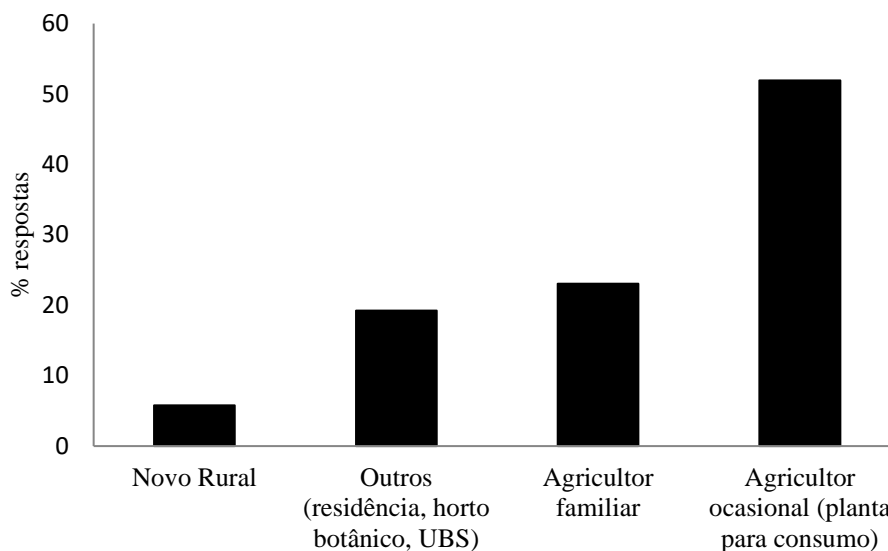


Figure 3. Percentages of profile responses and pattern of involvement with the ora-pro-nóbis culture in the Vale do Rio Paraíba do Sul in the Municipality of Pindamonhangaba, São Paulo, Brazil.

The most frequent form of consumption of OPN was in the form of raw leaves in salads (29%), as an ingredient in green juice (22%), in addition to bread and cake recipes (21%), in preparation with meat (17%), braised (5%) and in other diverse uses, such as stew, soup, lasagna and seasoning (Figure 4).

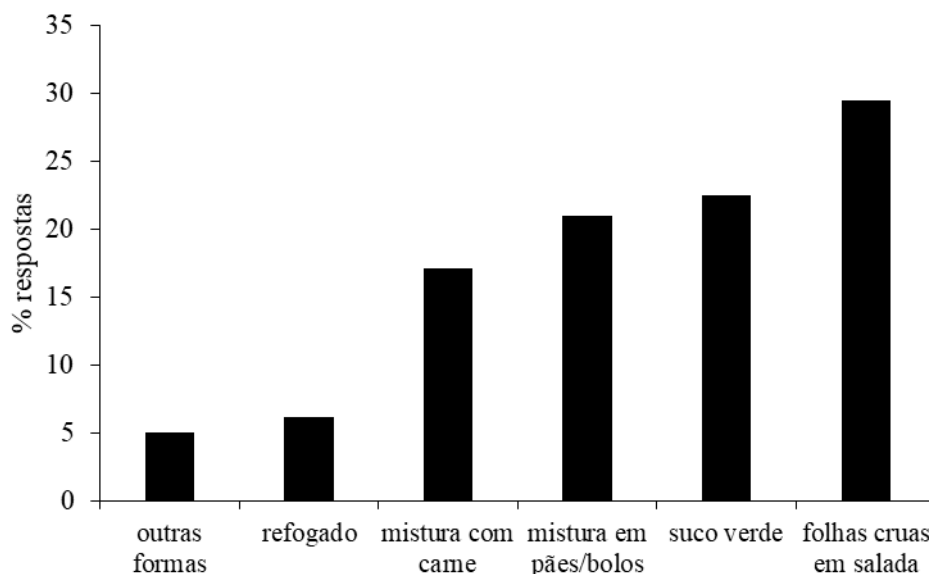


Figure 4. Percentages of responses on how ora-pro-nóbis is consumed in Vale do Paraíba Paulista, Pindamonhangaba, São Paulo.

In another survey, only 7.5% of students at a university in the state of Goiás stated that they had consumed OPN at least once, but 80% had not yet tried the plant due to a lack of knowledge of its nutritional value (JESUS; REGES, 2019). The consumption of OPN needs to receive more incentive to consolidate itself as a typical ingredient in Brazilian cuisine, with actions linked to government food acquisition programs to assist in the valorization and structuring of production chains surrounding this culture.

In Vale do Paraíba Paulista, OPN is being sold by 28% of the people who participated in the research, predominantly in the fresh form (71%), as an ingredient in bread and cake recipes (14%) and flour (14%). But only 12% of those interviewed process or process OPN leaves that could be consumed in various other ways. It is noted that OPN is highly valued in the food and pharmaceutical industries as dehydrated and ground raw material (ROCHA et al., 2008; DA SILVA et al., 2010; SILVA, 2019), or as a thickener and gelling agent for cosmetics. in the formulation of cream emulsions and ointments with special characteristics obtained from their mucilage (SILVA, 2019).

Figure 5 illustrates versions of other forms of ora-pro-nóbis-based products such as: hamburgers, protein bars and nutritious snacks developed by some of the eco-producers interviewed.



Figure 5 - Versions of other forms of ora-pro-nóbis-based products: burgers, protein bars and nutritious snacks developed by some of the eco-producers interviewed.

When asked about participating in a socio-environmental cooperative or franchise with a focus on the regional development of OPN culture with a view to reaching commercial scale in production, having the security of financial management of a company committed to the development of the vegetable protein production chain, half of those interviewed said they would accept to participate, but the other 50% did not and preferred to donate the production or keep it only for their own consumption.

Regarding management in OPN cultivation, 29% of interviewees do not carry out any cultural treatment, while the others indicate weeding (23%), green manure (16%), planting fertilizers (15%), top dressing (14%) and liming (3%) (Figure 6).

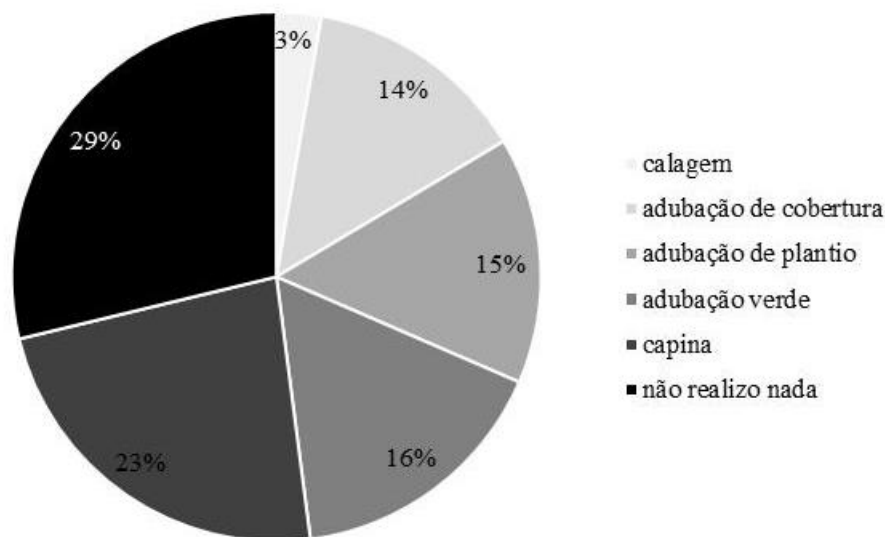


Figure 6. Percentages of responses about the type of fertilization and cultural treatments carried out in the ora-pro-nóbis culture in the Vale do Rio Paraíba do Sul, Pindamonhangaba, State of São Paulo, Brazil.

Successive pruning to control the growth of the plant, which has a climbing habit, and periodic fertilization, preferably organic, result in the production of stems, shoots and tender leaves all year round, in a safer harvest due to the smaller number of needles with this management. (MADEIRA et al., 2016). Despite the recommendations to carry out pruning, 33% of those interviewed reported not pruning the plants and this same percentage reported carrying out pruning once every six months, followed by those who pruned only once a year (27%) or once per month (7%) (Figure 7).

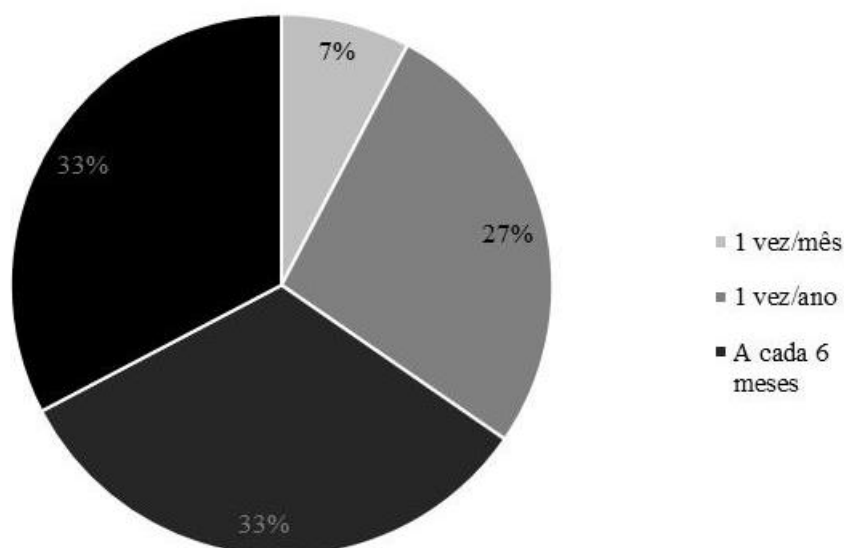


Figure 7. Percentages of responses on the frequency of pruning in ora-pro-nóbis in the Vale do Rio Paraíba do Sul, Pindamonhangaba, State of São Paulo, Brazil.



In the Paraíba Paulista Valley, the most common forms of OPN pruning are point pruning (48%) and lower pruning of plants to around one meter in height (46%), with cutting close to the ground being the least manageable. frequent (6%). Thus, the monthly harvest for 71% of respondents is between 0.5 kg and 1.0 kg of OPN in terms of fresh matter, 16% harvest more than 5kg and 13% harvest few leaves for immediate consumption. Madeira et al. (2016), reported successive and staggered pruning over seven years in the OPN crop to reduce the size and facilitate the handling of plants when harvesting young stems and leaves, in dense, non-irrigated planting in the Federal District.

When asked about how they harvest OPN, 58% of respondents reported using a knife or pruning shears and the remainder (42%) harvest manually by detaching the leaves from the stems. In Figure 8 it is observed that occasional (40%) and weekly (37%) harvesting are more common compared to the less frequent forms of every 15 days (17%) and just once a month (6%) (Figure 8).

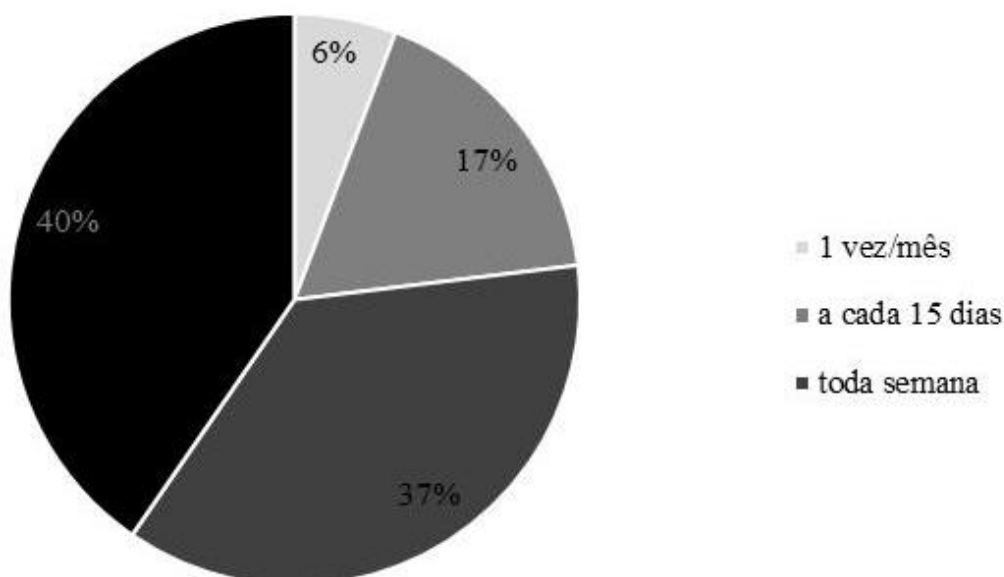


Figure 8. Percentages of responses on the frequency of ora-pro-nóbis harvesting in the Vale do Rio Paraíba do Sul, Pindamonhangaba, State of São Paulo, Brazil.

When harvesting the OPN, 75% of those interviewed reported having already suffered some type of accident, but of these, only 27% considered the spots to be an obstacle to harvesting, while 23% did not have an accident. The greatest difficulties in cultivating OPN are related to pruning and keeping the plant under control and 32% consider harvesting the greatest difficulty (Figure 9).



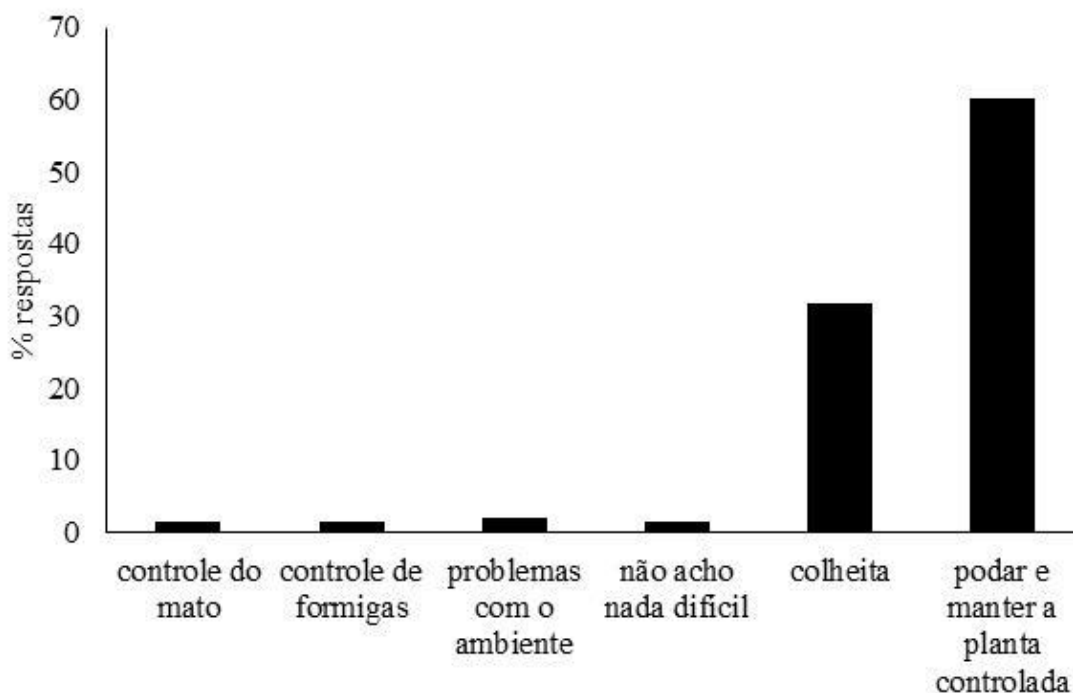


Figure 9. Percentages of responses about difficulties in cultivating ora-pro-nóbis in Vale do Paraíba Paulista, Pindamonhangaba, São Paulo.

The presence of needles considerably hinders the harvesting of leaves and leads people to eliminate OPN plants, due to the fear of suffering accidents, also because of the vigorous regrowth and climbing habit. Farmer protection techniques used where OPN is planted on a larger scale to meet industrial demand include the use of common pruning shears and personal protective equipment (PPE) – closed shoes with resistant soles, an “Arab cap” type hat for neck protection, long-sleeved blouse, glasses and thick glove on the hand used to hold the stems, in addition to the use of reinforced stainless steel mesh gloves and stylets to remove acules and leaves from the stems during OPN processing (MADEIRA et al., 2016).

Although 90% of people did not record the attack of pests and diseases in OPN, there were mentions of genera of leaf-cutter ants (*Atta* spp.) and quenquéns (*Acromyrmex* spp.) of wide regional occurrence foraging. However, when subjected to intensive management to meet industrial demand in the Center-West region of Brazil, the OPN presented serious phytosanitary problems, such as leaf lesions caused by bacteria of the genus *Xanthomonas* and fungi of the genera *Cercospora*, *Septoria*, *Puccinia*, in addition to nematodes- galls (*Meloidogyne* spp.) that attack roots and harm plant development (MADEIRA et al., 2016).

Considering the results of Madeira et al. (2016), and because the climate of Vale do Paraíba Rio Paraíba do Sul Paulista is more favorable to the occurrence of diseases, due to the high cloudiness and high rainfall between the months of September and February, caution must be exercised when encouraging expansion of the production scale. New research seeks to validate cultivation techniques and generate recommendations for producers for the safe insertion of PANC in agroecological production systems in order to preserve biological balance (DURIGAN et al., 2023).



## CONCLUSIONS

Ora-pro-nóbis is an unconventional food plant (PANC) valued for its high protein and nutritional content as a traditional food widely used in the Paraíba Paulista Valley.

The conservation of a few plants in backyards and farms has been sufficient to provide fresh leaves for family consumption in the most diverse forms (in natura, green juice, bread and cakes, stewed with meat).

The main obstacle to expanding this culture is related to the need to systematize pruning management to keep the plants low and avoid accidents with needles during harvest.

## THANKS

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