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EVALUATION OF ETHNOBOTANICAL RESEARCH DEVELOPED IN THE PERUVIAN CONTEXT (2000-2013)

EVALUACIÓN DE LAS INVESTIGACIONES EN ETNOBOTÁNICA DESARROLLADAS EN EL CONTEXTO PERUANO (2000-2013)

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ABSTRACT

The quality of 110 ethnobotanical studies performed in Peru and published during the last thirteen years in peer-reviewed journals was evaluated through an index of research performance, the RPE index. This index assumes a maximum value of one and is composed of ten indicators. The studies with a better performance are valued with scores of the RPE index > 0.5. The indicators were monitors of the expertise on plants of the informants, the experience and specialization of research leaders, the use of participatory techniques during the research, the multidisciplinary character of the research team, the funding support attained, the scientific production, the citation in Google Scholar and the achievement of prior consent from the studied human group. The results show that the studies with scores > 0.51 were performed mainly by foreign scientists, recognized as experienced scientists with training in biological sciences, with a scientific contribution resulting from the ethnobotanical research, and as part of a research team. Furthermore, the studies with best performance were conducted primarily by pharmacologists, scientists from the social sciences and biologists. The studies performed by Peruvian ethnobotanists exhibit lower scores of the RPE index due to factors such as low scientific production and lack of funding support.

Keywords: Ethnobotany, indicators, performance, Peru, RPE index.

RESUMEN

Se evaluó la calidad de la investigación en 110 estudios etnobotánicos realizados en Perú y publicados durante los últimos trece años en revistas revisadas por pares mediante un índice de performance de la investigación, el índice RPE. Este índice asume un valor máximo de uno y se compone de diez indicadores. Los estudios con una mejor performance se valoran con valores del índice RPE> 0,5. Los indicadores midieron la experiencia sobre plantas en los informantes, la experiencia y la especialización de los líderes de la investigación, el uso de técnicas participativas durante la investigación, el carácter multidisciplinar del equipo de investigación, el financiamiento obtenido, la producción científica, la citación en google scholar y el logro del consentimiento previo del grupo humano estudiado. Los resultados muestran que los estudios con un índice RPE > 0,51 fueron realizados principalmente por científicos extranjeros, reconocidos como investigadores experimentados, con una formación en ciencias biológicas, con una contribución científica derivada de la investigación etnobotánica y como parte de un equipo de investigación. Además, los estudios con mejor desempeño fueron realizados principalmente por farmacólogos, científicos de las ciencias sociales y biólogos. Los estudios etnobotánicos realizados por científicos peruanos exhiben las puntuaciones más bajas del índice RPE debido a factores como falta de apoyo financiero para la investigación y una baja producción científica.

Palabras clave: desempeño, Etnobotánica, indicadores, índice RPE, Perú.

INTRODUCTION

The Ethnobotany is the field of ethnobiology in Peru which count with more papers and citations. (Albuquerque *et al.* 2013). The study of the local knowledge about plants from human groups whom live mainly in the Andes and in the western Amazonia is the ground wherein is developed the ethnobotany research in Peru. In fact, at least 64 ethnic groups live in the Peruvian Amazon using equal number of living languages (Lewis 2009). In Peru the research in ethnobotany is based on the study of medicinal and edible plants (La Torre-Cuadros & Albán-Castillo 2006). For this reason, the research on medicinal plants has been included in the Peruvian science policies by the National Council on Science, Technology and Innovation (CONCYTEC 2006). The ethnobotany studies performed in Peru reach importance in the contemporary science. Examples of these contributions are the use of quantitative ethnobotany to predict the use value of plants in the Peruvian Amazon (Phillips & Gentry 1993), the ethno pharmacological studies on hallucinogenic plants (Dobkin 1968, Schultes *et al*. 1977), the ethno ecological studies in Andean agriculture (Brush 1992), ethnobotany of Amazonian peoples (v.g. Alexiades 1999) and the paleo-ethnobotany works.

Despite the development of ethnobotany in Peru, no effort has been made to search for an assessment of the research on this field. The measurement of the research performance could raise the scientist's productivity and improve the research quality (Bornman 2010). Is unknown the use of indicators to evaluate research performance of ethnobotany studies made in Peru, but there is evidence of the research capacity of scientific institutions through their outcomes as publications and some governmental information (v.g. UNCTAD 2011, Lemola *et al.* 2011). Nowadays, in Perú the ethnobotany research is a result of the cooperation between

governmental agencies and NGOs with academics from universities. In Peru, many ethnobotany studies had been developed in collaboration with foreign institutions. The case of the ethnobotanical studies of palms in Peru is illustrative. According to the data cited by Albán *et al*. (2008), 57% of the ethnobotanical studies about palms which took place in Peru between 1962 and 2006, were performed in collaborative research between Peruvian academics and foreign scientists.

On the other hand, both private and public organizations are induced by the new world order to show the reliability of their work through the measures of results by using indicators. In this sense, Hailey & Sorgenfrei (2004), mention that NGOs and development agencies are under pressure to justify their work and document effective performance using measures and onerous evaluatory systems. In Peruvian public agencies the projects are lead using the approach of results based management. Meanwhile, the activities developed by NGOs are advised by the donors using diverse mechanisms such as the logic framework.

For the assessment of the research in ethnobotany is important take into account the proper use of the methodology in the field work and the quality of the manuscripts submitted to journals. In this sense, amongst the most frequent problems that occur in ethnobotany research, are noticeable the observations about the validity of informant's expertise (Davis & Wagner 2003), the reports that do not contain proper information about the biological and social context (MacClachtey 2006, Reyes-Garcia *et al.* 2009), the insufficient sample efforts because the results show a low number of informants in comparison with the high biodiversity of the study zone (Begossi 1996, Begossi *et al.* 2002), and the not adequate interpretation of results concerning phenomena as acculturation an LK eroded (Albuquerque & Hanazaki 2009). These problems could be detected using indicators to measure data as: age of participants, living time in the study zone, training and experience of researchers, the number of informants per plants or the ratio of informants by studied community.

Another aspect that requires an assessment is the multidisciplinary character of the research team. Commonly, the collaboration between scientists may be evaluated through the number of published papers in co-authorship by one team. In these terms, the interaction of co-authorship with productivity is only one aspect of interaction with performance (Glänzel & Schubert 2004). Unfortunately, the scientific filiation of researchers might be not registered in some databases. It is critical because the ethnobotany is a field which involves different disciplines, from the botany until the ethnoecology (Nolan & Turner 2011). Further, taking knowledge about the team composition is possible to make decisions in order to define the orientation of the research or to assign responsibilities within the staff.

An ethnobotanical study is based on the gathering of field data, many times carried out in distant places and in hard conditions. It requires an adequate support to perform long-term studies or the surveys with the rapid appraisal approach. Unfortunately, CONCYTEC and the public research institutes have insufficient funds to national researchers. In some cases, foreign agencies and universities from other countries provide funds to Peruvian academics for to made research. The Peruvian counterparts offer institutional support giving logistics and obtaining bureaucratic authorizations of the government to take biological samples and to have access to national protected areas, or to get permits from the indigenous organisations. But, in some cases, the research support is not specified in the publications and in the databases.

The funding of public R&D institutes in Peru

depends on public budget, taxes from mining activities and foreign funds. The IIAP (Research Institute of Peruvian Amazon) is perhaps the Peruvian R&D institute with the greater scientific production in ethnobiology and count with 26 researchers. The public expenditure in R&D activities at IIAP during 2010 was approximately US$ 6,5 million (Lemola *et al.* 2011). With this information is relatively easier the estimation of the support received by each researcher.

However, the funds used in Perú by a NGO are variable. While COMARU organisation receives annually a grant of US $ 105 000 from OXFAM (Earlie & Pratt 2009), the CIPS Sara Lafosse NGO made an expenditure of US $ 29 000 during 2011 (Proetica 2012). In opposition, the information offered about the used funds by some NGOs in Peru may be not clear, as Panfichi & Angeles (2008) suggest. Moreover, a NGO may obtain funding from many donors and therefore these resources would be shared among different projects, making hard the estimation of support receipt by each researcher. Then, non-quantitative indicators may be preferable to measure support for non-governmental organisations.

The research capacity of institutions involved in a collaborative research is also a part of the support. If the data or other materials are processed out of Peru, it would be considered as a sort of support, but it is criticized by Cuevas *et al.* (2005), whom claims that in these cases the participation of the Peruvian counterparts is simply as collectors of samples. In this context, the estimation of the funding support is more objective and credible than the use of data from institutional support at the moment of an assessment of the research performance.

According to the previous review, the quality of an ethnobotanical study in Peru could be measured using data from the studied population, of the researchers involved and its research outcomes as well as the funding achieved. The purpose of this work is the proposal of ten indicators that comprise an index for the assessment of ethnobotanical studies conducted in Peru based in their research performance.

MATERIAL AND METHODS

The Peruvian context

In Latin America the ethnobotanists have been considered scientists with a broader formation, with an inter-disciplinary perform applied mainly in the study of plants with phytochemical properties (Schultes 1962, Alexiades 2003). In the South American context, Bermudez *et al.* (2005), refers that an ethnobotanist should be ready to record the traditional knowledge about plants, applying techniques to process data obtained from the people, evaluating the plants with pharmacological studies and finally, participating in compensation mechanisms to return benefits to the studied communities. Meanwhile, for Albán (1985), the main goals of the ethnobotany in Perú are: the rescue of the empiric knowledge about endangered plants, the study of traditional management of vegetation related to the imminent change in the nature, the study of ancient societies working in collaboration with anthropologists and geographers, the collaboration with phytochemical, pharmacological and medical research, and the collection of vegetal material with propagation purposes for aid to solve medical, biological, agricultural and other national problems.

But the science advancement in Peru would be qualified as of lesser development. For instance, Peru exhibit a modest indicator of 0.4 researchers by 1000 persons from the labour force, an expenditure in R&D of 0.1 % of GNP, and a very few applications for patents

(CONCYTEC 2006, Le Marchand 2010). The assessment of the scientific activities developed by the Peruvian universities during the recent years indicates the concentration of scientific production in three institution, and a lower rate of academics with specialization (Piscoya 2006). Similar indicators were used to evaluate the performance of public R&D institutes of Peru by Lemola *et al.* (2011) and a low rate of post-graduated scientists, some institutes with a very small scientific production, and none patent registered by them were encountered.

Nevertheless, Peru is a country with a greater concern in the world due to their higher biological and cultural diversity (Maffi 2005, Loh & Harmon 2005). In this sense, ethnobotanists have the important mission of aid to the conservation of indigenous people's culture and natural resources encountered in their study zone. The ethnobotanists are considered as mediators between different knowledge systems and their work is recognized as crucial during the collection, dissemination and taking part in the research about the use of the plants (Alexiades 2003). Thereby, depending of the role assumed by an ethnobotanist, the traditional knowledge about plants may be used benefiting to the humankind or for to enrich transnational laboratories. An attempt to protect the traditional knowledge of indigenous peoples about plants was the adhesion of Peru as party in the Convention of Biological Diversity, and the subscription of the Nagoya Protocol and the international treaty so named "Decisión 391" about the access to genetic resources in the countries members of the Pact of Cartagena. The shared benefits between indigenous peoples and contractors derived of the use of traditional knowledge on plants are implemented in Peru by regulations such as the Law Nº27811 that establishes the protection regime for the collective knowledge of indigenous peoples relating to their biological resources.

The backward mentioned aspects of the ethnobotany research in Peru must be assessed to improve the products of the ethnobotanical research such as: publications, patents, scientific discoveries, herbaria collections, new methodologies, among others issues. The results of an assessment of the research capacity of scientists and institutions involved in ethnobotany can aid to improve aspects as the scientific quality of the reports, the productivity of the scientists, the support provided by the institutions, and the use of best research methods.

Assessment of the performance in ethnobotanical research. Methodological directions.

The performance ("desempeño" in Spanish) would be defined as the well development of an activity. In science, the performance is related with the research quality which in turn depends of the research capacity or the factors that influence the outcomes of the scientific investigation. There is not an accord about these factors and the role which each play in the research outcomes, but some of them are the funding, the team size, the age of researchers, the productivity of staffs, the collaboration between scientists, or the disciplines involved in the research (Cohen 1991, Carayol & Matt 2006, Laudel 2005, Glänzel & Schubert 2004, Hailey & Sorgenfrei 2004, Porter *et al*. 2007, Porter & Rafols 2009, Franceschet & Costantini 2010, Guthrie *et al.* 2013).

Previous ethnobotanical studies in Peru contributed with the identification of the factors which have an influence on the quality of the collected data. In the case of the well-known research of Phillips & Gentry (1993), was encountered that the data provided by informants could be influenced by their age, sex or degree of acculturation. Meanwhile, Kvist *et al.* (2001) refer that an effective method to collect ethnobotanical data in the

Peruvian context, is characterized by its credibility, the use of cultural consensus methodology, their participatory approach, the record of knowledge about use, the preparation and effects of the medicinal plants, and the collection of information about the habitat of the plants. Some of these factors are taken into account to build the indicators of research performance in the present work.

The performance of the ethnobiology research in Peru was evaluated by Pizarro (2009), who suggested five indicators to measure effort of researchers, multidisciplinary character and composition of the team, outcomes and the cooperation between involved institutions. This work was used as a reference to build the indicators and therefore assess the performance of an ethnobotany research.

At the international level, the indicators of research performance have been developed to measure those variables that influence the quality of the science and technology activities. For instance, based in the work of Archibugi & Coco (2005), the results of the ethnobotany research might be measured using indicators of productivity, of infrastructure, and of the human resources involved. It was an inspiration to support the idea that the research performance in ethnobotany, should be measured considering the academic contributions, the institutional support as well as the human skills of the researchers. The proposed indicators by the "Red de Indicadores de Ciencia y Tecnología Ibero/Interamericanos" (RICYT 2009) to measure activities of science and technology were designed following criteria as the tangible outcomes of the research and visibility of the scientific production. Precisely, these two guidelines have been followed to build the indicators in this work.

In spite of that data from publications are used mainly to measure the research performance, Guthrie *et al.* (2013), indicate different tools, apart the bibliometrics, which could be used with purposes of research evaluation, such as: surveys, logic models, case studies, site visits, interviews, document review, among others. In our case, the data used to measure research performance were obtained from the corresponding authors, their published papers as well as of the author's profiles retrieved in many sites of internet.

The proposed indicators.

Using this background were selected ten indicators for to build an index, which serves to measure performance in ethnobotany studies according to the Peruvian context. Througgh the use of multiple indicators is possible measure different aspects of the research performance and the probability of data manipulation by the evaluated subject would be reduced (Martin 1996). An indicator is a measure that explicitly addresses some assumption (Van Raan 2004). The indicators presented here are recognized as measures of the conditions under which were conducted the ethnobotany research in Peru. Two of them are quantitative indicators due to the subject to measure is comprised by more of one attribute or variable, these cases are the indicator of Multidisciplinarity (M) and the Support indicator (S). The remaining indicators are qualitative and are used to measure if the assumption is true or false. If a qualitative indicator was valued with a score of one is because an assumption was proved, and was valued with zero in opposed case. The qualitative indicators measure the expertise of informants and scientists, the scientific contribution of the study, the use of participatory techniques during the survey, the citations in Google scholar, and the willingness of the informants to participate in the study (see table 1).

The indicators has been designed to measure three steps of the research process: input indicators (experience of leader researcher,

Table 1. Indicators of the Index of Research Performance in Ethnobotany (RPE index).

INDICATOR	ASSUMPTION	VALUE
Informant Expertise Indicator (IE)	At least 50% of informants should be have 40 years old or more ($N_{>40}$) due to this group is probably more knowledgeable.	1 if ($N_{>40}$) ≥50%
Experience of researcher (ER)	At least the scientific leader of the team is an experienced ethnobotanist.	1 if the researcher was a participant in prior studies.
Ethnobotany specialization (ES)	At least the scientific leader of the team is a researcher with specialization in ethnobotany or is biologist, anthropologist, economist or pharmacologist.	1 if the researcher has a formation in any of the mentioned scientific fields.
Use of Participatory techniques (UP)	During the field work were used participatory techniques to obtain ethnobotanical data from the informants.	1 if the paper examined reveals the use of participatory techniques in the methods.
Multidisciplinary indicator (M)	None discipline have a dominance in a multidisciplinary team.	"M" adopt a value of zero when D=1. In other case "M">0. "M" near to one is an ideal result.
Support indicator (S)	Each research should be supported at least by an institution.	"S" can adopt a value > 0 when the study have a support. "S" is zero when is not mentioned neither funding support to the research in the paper.
Scientific Communication indicator (C)	The results of each research must be published in a peer reviewed journal.	1 if the results of the research were published in a journal peer reviewed.
Academic contribution (A)	The research produces materials available to other researchers such as: herbaria vouchers, audio-visual recordings, maps, among others.	1 if any contribution mentioned in the paper is deposited and registered in either academic institution.
Google scholar citation indicator (G)	The study has an impact above the average of all analysed studies.	1 if the study reaches a number of citations over the average of all citations in the present study.
Prior consent indicator (PC)	An authorization from the human group studied to use the gathered information was obtained by the researchers	1 if the prior consent was attained from the studied community and mentioned in the paper.

specialization of leader researcher, multidisciplinarity indicator, support indicator); process indicators (prior consent indicator, Informant's expertise indicator and use of participatory techniques indicator); output/outcomes indicators (scientific communication indicator, scientific contribution indicator, and the Google scholar citation indicator).

1. The Informant's Expertise indicator (IE).

Local knowledge expertise indicator is proposed to improve the quality of data gathered during the ethnobotanical study. It is build based in the followed two assumptions. First, the knowledge will be eroded by influence of western culture (and the changes product of globalization), and precious information from indigenous peoples and

knowledgeable portion of the Peruvian population is next to disappearing, then is precise avoid this loss. By other side, is assumed that the knowledge accumulated by the informants considered experts or with great experience in the traditional use and management of plants, is influenced positively by their age, thereby is precise the rescue of this knowledge from the elders and the adults born during or before the social transformations produced by the economic development during the second half of the twenty century in Peru.

In some ethnobotany studies, has been demonstrated that the older informants made more citations of plant species than the younger informants (Begossi *et al*. 2002), or have more knowledge about the uses of plants (Quinlan & Quinlan 2007). Phillips & Gentry (1993) encountered a relation between age and medicinal plant's knowledge and suggests take more attention in the study of them due to their vulnerability in front to the people's acculturation.

Precisely, the changes in cultural patterns within the Peruvian rural communities and in the cities could be explained by the human migration from the rural places to the cities (Mayer 1970). These migratory process generated an explosive growing of the urban population in Peru between 1961 and 1972 which was the most strong in the country history, with 5.1% (INEI 1994). Is expected that the majority of informants who come from rural villages and have 50 years of age or older at this time, learned more about plants due to a prolonged contact with their environment. Indeed, the recognition and naming of plants begin earlier, during the childhood (Berlin 1999). As suggest Ross *et al.* (2003), the folk biological background in rural children is more developed due to both cultural reasons and a direct experience with the nature. Hence, is desirable that some part of the informants in ethnobotanical surveys could count with more of 40 years of age for to avoid the loss of information from experienced adults.

In the case of acculturated informants, the expertise in plants is enough important because, as is explained by Godoy *et al.* (2009), the ethnobotanical knowledge is dynamic and would be influenced positively by socio-economic changes. It could be the case of the mestizo group or of the migrant peoples to urban zones. At respect, Phillips & Gentry (1993) defined the "mestizo" group as colonist from the Andes or people whom came of different places of Peruvian Amazon living during more of thirteen years in Madre de Dios, the study zone. In other words these persons had an age >30 years at the moment of the study, twenty years ago. Phillips & Gentry predict that informants with 67 years are more knowledgeable in medicinal plants than the group of 40 years of age. Although, according with the authors, the younger mestizo men are less motivated to learn about medicinal plants than the older men and women. In similar way, the Andean women maintain their cultural heritage much better than the men (Bouroncle 1990). It introduces a new factor which influences on the expertise about plants amongst the acculturated informants, but would be not significant when the informant has been more adult.

From another view, Ramirez (2007) refers that the loss of traditional knowledge about plants is accelerated in many developing countries because the biodiversity is decreased or the access to natural resources is blocked. In Peru, the building of roads from Andean regions to the coast and the consequent migration were causes of the urban population growth, an abandonment of beliefs, language, practices and the adoption of new customs to obtain social acceptance or a job (Hardman de Bautista 1985). In similar way, Hammil & Salick (2003) explain the changes generated in the agricultural and social patterns of the Yanesha ethnic group due to the aperture of the

road between the Andes and the Amazon well known in Peru as "carretera marginal". In the same sense, Vega (2001) consider that the intensity of the violence practiced against the Amazonian human groups, the migration of colonists from the Andes that occupied the Amazon territory, and the increased presence of governmental institutions in these region has increased since the seventies. These events are linked with the acculturation of indigenous peoples in both the Andes and Peruvian Amazon and would be a reference to estimate the ideal age of our informants with expertise in the identification of useful plants.

The Informant's expertise indicator was built under the assumption of that the informants with more of 40 years ($N_{>40}$) could be a best source of information about plants than the informants under 40 years of age ($N_{<40}$). For ethnobotanical studies the Informant expertise indicator should be equal to 0.5. It could be means that the probability of encounter knowledgeable informants will be at least 50%. With purposes of standardization of the data from studies carried out according different methodologies, the Informant Expertise Indicator assumes a value of 1 in any of the followed cases: if N>40 is 50% or more of the informants, if the age average of informants is 40 years or more, and if the median of the age is 40 years or more.

2. Researcher experience (RE).

To be considered an experienced researcher in ethnobotany, the main author should have prior experience driving a thesis work in ethnobiology, or as member of a team in ethnobotanical surveys. To obtain this information was reviewed the CV of the main author. This indicator serves to evaluate the knowledge about ethnobotany methods as well as the field expertise in the conduction of a survey under certain climatic or geographical conditions, the fluency in the languages spoken in the study zone or the skills to solve problems about the applied method to collect data from informants and samples in the field. The experience in science has been correlated with the scientists age (Cohen 1991). In addition, the prestige of experienced researchers within scientific community could be having influence at the moment of to obtain funds for research (Laudel 2006, Savo *et al.* 2011). Then, if the main author or other member of the research team is an experienced scientist in ethnobotany, the Research Experience Indicator assumes a value of 1.

3. Ethnobotany specialization (ES).

Brusoni & Geuna (2004) manage the concept of specialization as the knowledge generated via a progressive process, where in new fields of knowledge are developing out of pre-existing fields, and quite often complementing them. To evaluate specialization in ethnobotany, the research leader or corresponding author should be having a specialization in ethnobotany or in fields such as: biological sciences, anthropology, agronomy, economy or phytochemistry. The result is that at least the senior researcher or corresponding author of the paper has an adequate formation in a discipline related with the study of the relationships between the man and the plants. These data too are from the CV of the main author.

4. Use of participatory techniques (UP).

The use of participatory techniques during the survey is a characteristic of the rapid appraisal approach in ethnobotany (Martin 1995). Through this research method people enhance their capacity of reflection about the studied subject. These techniques can stimulate local insights that may have arisen during informal discussions or during interview surveys (Cunningham 2001). The products of the application of participatory techniques in the Peruvian context are wide and comprise cognitive maps (Gilmore & Young 2012),

forest walks (Luziatelli *et al.* 2010), or explain social and cultural processes like calendars of crop harvest (Gomez & Pizarro 2001). Moreover, these techniques could be a complementary resource to the classical interviews. If the use of a participatory technique is mentioned in the paper, the indicator UP indicator assumes a value of one.

5. Multidisciplinarity indicator (M).

Ethnobotany is defined as the study of the plant-man relationship through of different scientific disciplines (Martin, 1995; Alexiades, 2003). In Peru many ethnobotanists are primarily biologists or physicians, with the expertise to be able to identify species and with knowledge about ethnology, ecology and pharmacology of the plants. However, anthropology, linguistics, economics, chemistry or geography, are disciplines that contribute to the contemporary ethnobotany of Perú as well. Therein, is expected that the composition of the research teams which perform ethnobotanical studies may be diverse, although some disciplines could reach certain predominance. At respect, Franceschet & Costantini (2010) argue that the contributions of social sciences researchers are smaller in scale and formality within the teams, in comparison with the collaboration of other scientific disciplines. Moreover the indicator of multidisciplinarity is not sensible to these interactions among disciplines, resulting well convenient because only a little fraction of ethnobotanists come from the social sciences.

The multidisciplinarity indicator (M) is formulated through the next expression:

$$M = 1 - [(1/\sum ri) / \sum D]$$

This indicator measures the dominance of a given discipline using the variables: number of scientists in the staff (ri) and the number of disciplines involved in the research team (D). The dominance of a discipline occurs if the multidisciplinarity index assumes a value near to zero. The "M" indicator must be near to one in an ideal multidisciplinary team. If the team is composed of researchers from only a single discipline (D=1), "M" is zero. This index could be applied to evaluate the orientation of the team based in the output products corresponding to each discipline involved in the project.

6. Support indicator (S).

As was noted by Laudel (2006), in general terms, the research quality and the innovation in science could be negatively affected by the unavailability of funding. This situation is critical in the case of the collaborative science which requires large personnel and is strongly dependent of the financial support (Glänzel & Schubert 2004). The kind of support would have some influence over the results of the interdisciplinary research teams. Lundberg *et al.* (2006) assumes that the information about the research funding could be used as an indicator of collaboration between scientists that often is not detectable through co-authorship analysis. On the other hand, Laudel (2005) refers that the success to obtain funds for research could depend of the proximity of the research centres to the support institutions, of the quality of the proposal, and would be influenced by the prestige of the researcher. The support indicator could be a sort of compass to detect these conditions.

The support indicator (S) was proposed to visualize the funding support obtained by a project and is expressed as follows:

$$Si= (\Sigma I)/I_{max}$$

Where "I" represents the number of support institutions mentioned in each research, and I_{max} is the higher number of institutions supporting a research registered in the database of this study. In our case I_{max} reaches a value of 8 support institutions by study

corresponding to the studies of Gilmore *et al.* (2012) .

7. Scientific Communication indicator (C).

The scientific communication indicator is a measure of the scientific production of an ethnobotanical study. It is an outcome indicator, not an impact measure. According with the goals of all scientific investigation, the results should be disseminated adequately for the enhancement of the scientific knowledge. But, for attain it; the communicated results should have visibility and retrievability. These are important attributes of the certification, registration, awareness and archival functions of the scientific communication (Kircz & Roosendaal 1996). The visibility of the scientific literature from Peruvian ethnobotanists is little because it has been published in local journals with very low impact. According with RICYT (2009), the visibility of the scientific production is attained through the publication of the research outcomes in international journals and in internet. The visibility of the scientific production which was written in Spanish could be diminished. At respect, there are evidences about that the non-English publications have less citations than the journals published in English (Van Leeuwen *et al.* 2001). In any case, the publication of an ethnobotanical research in a journal peer reviewed (JPR) permits the validation of the research quality of the study through the examination of the report by an editorial team after its submission to a journal. Other benefit of the publication of an ethnobotanical study in a JPR is their indexation in a database and therefore their availability for other researchers.

To evaluate the Scientific Communication indicator (C) is used the published report in a journal. If an ethnobotany study was published in a JPR, this indicator reaches a score equal to one.

8. Academic contribution indicator (A).

The academic contribution indicator (A), is an attempt to measure the production of materials derived from the ethnobiological studies such as: patents, conservation in botanical gardens, herbaria vouchers, audio-visual material from interviews, database of plants, maps and other products that should be remain in herbaria, museums, archives of universities or material uploaded to internet sites as part of an digital repository. In this way, is possible the assessment of research quality traduced in the existence of research lines in universities or R&D institutes. This indicator measures an outcome with great importance for the enhancement of the scientific knowledge. The collection of voucher specimens of plants is an example. In this sense, it is claimed by Nolan & Turner (2011) such as a necessity to the ethnobotany studies as well as the photographs. When a scientific contribution is mentioned as a product of the ethnobotanical study, the A indicator assumes a value of one.

9. Google academic citation (G).

The "Google academic citation indicator" is a measure of the relative impact of the ethnobotanical investigations over the researchers with publications uploaded to internet or detected by Google academic. The Google academic search engine was preferred due to their accessibility for great part of Peruvian academics and the great visibility of the articles uploaded in internet sites. The employment of Google academic is referred as a valid resource to be used to search publications which are not indexed in databases as ISI Web of Knowledge or Scopus (Harzing & Van der Wall 2008). It would be the case of some Peruvian journals published by local universities. A modification of the methodology of Van Raan (2004) was employed to estimate the impact of an article in Google scholar. Hence, was used the Google academic search engine to retrieve the number

of citations of each of the 110 papers of the database. The search was driven during December of 2013 and January of 2014 and thereafter the followed parameters were estimated:

-Papers searched in Google academics: 110 p.
-Papers encountered with citations: 96.
-Total number of citations: 2064 c.
-Average citations per paper: (2064 c.)/(110 p.)= 18,76.

Using these data, the Google academic citation indicator would be assumes the score of 1 if the paper reaches a value $\geq$ 18,76. It means that the paper was cited over the average of citations for this group of ethnobotanical studies. In any other case, the score of this indicator assumes a value of zero.

10. Prior Consent indicator (PC).

Finally, was built the "Prior consent Indicator" (PC) to detect if the research was developed protecting the willingness to participate of the human communities studied through an authorization or prior consent. The authorisation could be obtained from the leaders of the indigenous organisations or from each individual, but is desirable that it may be attained through a written document. In several institutions are encouraged to their members for the fulfilment of their Ethics Code where the prior consent is an exigency to perform a research. For instance, the American Anthropological Association considered that it is the responsibility of their members gets a prior consent informed from the studied human groups (AAA 2009). Meanwhile, the Ethics Code of the International Society of Ethnobiology state under the principle of Educated Prior Informed Consent that "… prior informed consent requires an educative process that employs bilingual and intercultural education methods and tools, as appropriate, to ensure understanding by all parties involved." (ISE 2006). In addition, international agreements as well as Peruvian laws regulate too the procedure to obtain authorisations from ethnic groups for began a survey, wherein informed consent is needed before of the field work beginning. Hence, the PC indicator reaches a value of one when the prior consent is attained and mentioned in the analysed paper.

Assessment of quality research in ethnobotanical studies through the Research Performance in Ethnobotany index (RPE index).

The proposed indicators were applied to evaluate 110 papers published between 2000 and 2013. The title of the article, authors, year of publication and journal wherein was published appear in the annex 1, which could be downloaded from http://indicadorestacna.orgfree.com/oct_2014/Anexos%20Articulo%20J%20Pizarro%20RPE%20INDEX.pdf or requested to the author. The referred publications were selected using the followed criteria: should be works with participation of informants with local knowledge of plants (reviews or essays were not considered), the articles were published in journals peer reviewed as: *Economic Botany, Ecological economics, Journal of Ethnobiology, Journal of Ethnopharmacology, Mountain Research and Development, Conservation Biology, Ambio, Human Ecology, Biodiversity and Conservation,* and *Forest Ecology and Management.* Some articles were selected from open journals peer-reviewed as *Ethnobotany Research and Applications, The Journal of Ethnobiology* and *Ethnomedicine* or *Evidence-Based Complementary and Alternative Medicine*. The Peruvian publications consulted were mainly journals with prestige, continuity and visibility in internet as: *Revista Peruana de Biología, Ecología aplicada, Folia Amazónica* and *Arnaldoa.* The selected articles are linked with the fields of the Ethnobotany referred by

Martin (1995) which are: botany, anthropology, ethnopharmacology, ecology, economics and linguistics.

The first step was the research of data about the ethnobotany studies made in Peru. The research began revisiting the Jstor database (www.jstor.org), researchgate (www.researchgate.com). Academia.edu (www.academia.edu), academic Google (www.scholar.google.com), and the personal database of the author, to search publications of ethnobotany studies performed in Peru and published in the last thirteen years. The key words employed in the search were "Ethnobotany" and "Peru". In addition to this, data about the prior experience in ethnobotany research of corresponding authors and the scientific formation of the researchers were searched in the web. Citation data of each selected article was obtained using the Google academic search engine. When was necessary, some authors were requested by e-mail to obtain information of their personal profile or publications. At respect, only twenty one authors reply the send mails.

Moreover, the followed data were obtained for each paper: author names, year of publication, title, age data of the informants, number of support institutions, academic contribution such as: herbaria specimens or other records from the field work, use of participative techniques with human group studied, and the prior consent obtained of the informants.

The second phase was the building of a database. For them was wrote a list in alphabetic order using a word processor, containing the followed data: author and title of the paper, number of citations in academic Google, number of informants with 40 years or more, number of researchers, prior experience of the corresponding author or more experienced author, scientific discipline of each author, number of funding institutions, journal that publish the research, kind of academic contribution, the citation in Google scholar, and the confirmation of the prior consent obtained of the studied community.

Finally, the data from the list was transferred to a statistic package to calculate the proposed index of research performance of each publication. All indices are summarizing to obtain the final index with an ideal score of 10 points.

The index of research performance of an ethnobotany study (RPE index) is an average number of the ten indicators calculated previously, according to the next expression:

$$\text{RPE index} = \frac{IE + ER + ES + UI + M + S + C + A + G + PC}{10}$$

The score is in relation with four ranges (0-0,25), (0,26-0,5), (0,51-0,75) and (0,76-1,0). An ethnobotany study with values within the last two ranges is interpreted as a research with acceptable quality for the Peruvian context.

RESULTS

The index of research performance in ethnobotany studies (RPE index) was applied to assess 110 studies, those reaching scores among 0,1 to 0,83. These results appear in the annex Nº2 and may be downloaded from http://indicadorestacna.orgfree.com/oct_2014/Anexos%20Articulo%20J%20Pizarro%20RPE%20INDEX.pdf or obtained taking contact with the author. Only 50% of the ethnobotany studies performed in Peru would be qualified as with acceptable research performance corresponding to the score range of 0,51 to 1,0. Besides only 4,5% of the studies of this range reached an RPE index score between 0,76 and (1,0) therefore would be considered with high performance.

Studies conducted only by foreign scientists reach higher scores of the RPE index than the

studies carried out only by Peruvian scientists (see fig. 1). Indeed, only 10% of the analysed studies were performed only by Peruvian researchers. However, the ethnobotanical studies with lower scores of the RPE index correspond to those that were performed by Peruvian scientists. These data confirm low quality as well as low quantity of the ethnobotany research among the Peruvian scientific community.

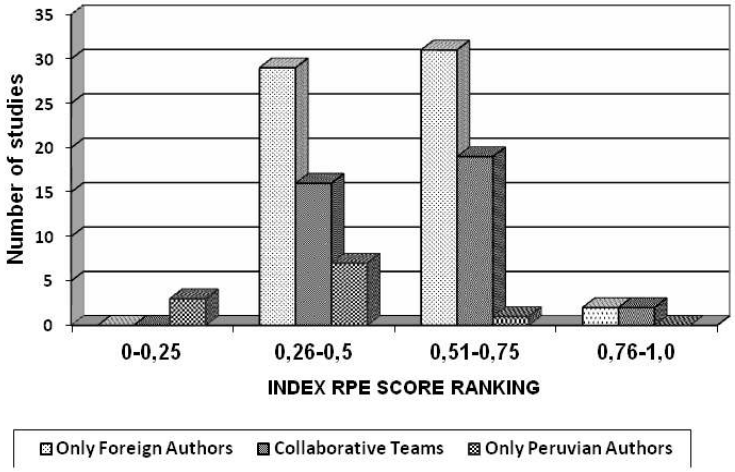

Figure 1. Research Performance index in ethnobotany studies (RPE) performed in Peru and published during 2000-2013.

A lower research performance in the ethnobotany studies performed in Peru is due to low scores of certain indicators. According with the accumulated scores of indicators used to estimate the RPE index, the indicator with more low score was the indicator "Expertise of informants" (IE) (fig. 2). The indicator IE is introduced in this work to detect the fraction of informants with 40 years or more. In this case, only twenty four papers contain information to calculate the proportion of informants with 40 years or more. Other papers offer diverse information about the age of participants such as: age range or the time living in the study site, but these data is unusable for estimate the age of informants.

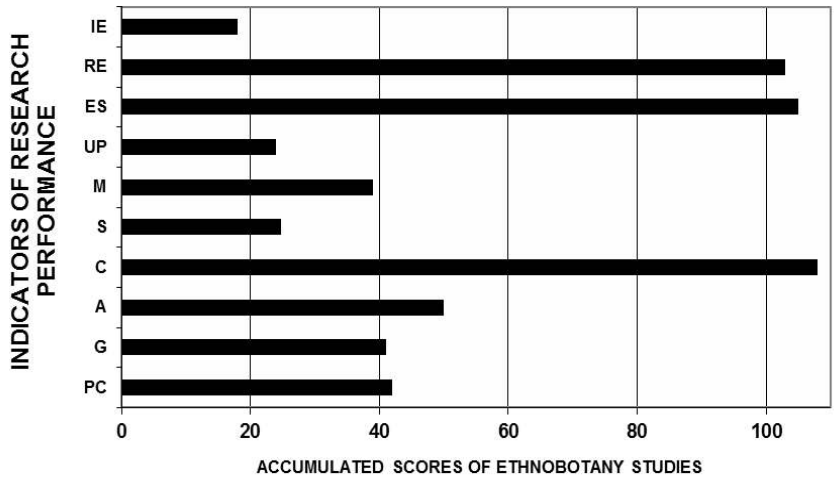

Figure 2. Accumulated scores of RPE indicators of ethnobotany studies performed in Peru and published during 2000-2013.

Many studies with more research quality reach a RPE index score between 0,51 and 0,83. It is due mainly to the contribution of certain qualitative indicators as PC, A and G (see fig. 3). Only in few studies were encountered data which serve to estimate that at least 50% of the informants had 40 years or more at the moment of the survey. It could reveal the use of different methodologies to obtain survey data. For instance, a randomly sample which includes informants from different age requires pay attention for to collect data from the older people as well as from the youth of the studied population.

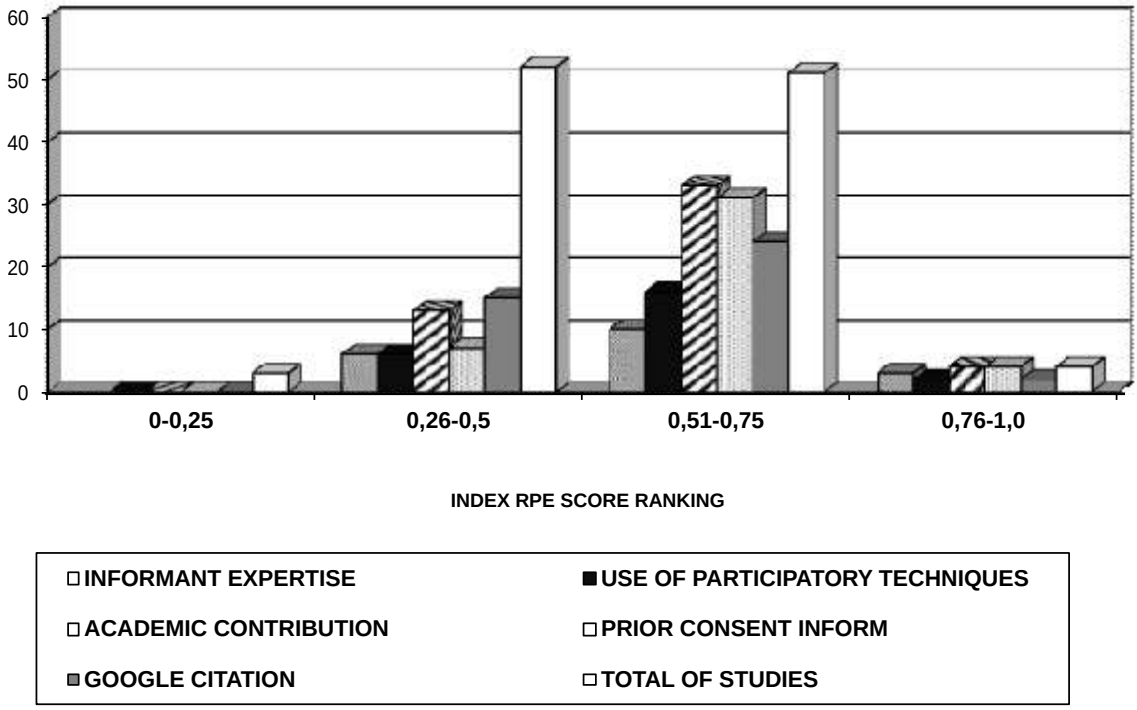

Figure 3. Scores of five indicators of RPE Index of Ethnobotany Studies performed in Perú and published during 2000-2013.

According to the results, only 16% of the authors explained adequately about the age of informants in their reports. But the studies which used ethnobotanical data from informants with a wide age range are predominant amongst those with best performance (fig. 4). On the other hand, 42% of the analysed studies are based in the ethnobotanical data provided by expert informants. Probably in these cases the data collection about the informant's age is not indispensable. Nevertheless, in spite that every ethnobotany research requires data according with the employed methodology, all studies should inform with detail about the characteristics of the human group under study. In any case, are needed methodological procedures which will be allow count with the basic information about the studied human group for to make inferences about the relationships between the informant's age and the quality of the obtained information. In the studies with best performance is predominant the use of data collected from informants with a wide range of age.

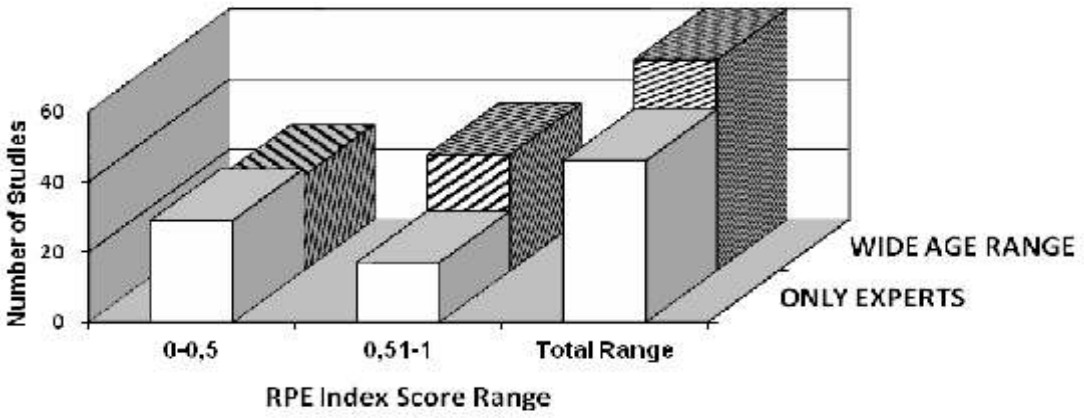

Figure 4. Ethnobotany studies performed in Peru by data collection method.

According with the results, 48,15% of the studies with an index > 0,5 have a number of citations in Google scholar over the average of the all citations, while only 28,84% of the studies with a RPE index score $\leq$ 0,5 were cited by over of this average. On the other hand, the studies with a very low RPE index score and some studies with high performance have none citation in Google scholar.

Other indicator with low score is the indicator "Use of Participatory techniques". Through this indicator is possible know the methodology used by the researchers to the gathering of ethnobotanical data. The studies performed by teams with social sciences researchers obtained a score that indicates the use of some participatory techniques during the field work. The results reveal that in the studies carried out mainly by teams with social sciences scientists were used participatory methodologies (fig. 5).

The participatory techniques mentioned in the papers are the participant observation, the forests walks and the focus group. In addition to this, the cognitive techniques used in some studies were the cognitive maps and the pile sorting. The use of participatory techniques were used more frequently in the studies with a RPE Index score with values >0,5 (fig. 6). It would be means that there is an evidence of a relationship among well research performance and the use of participatory techniques in the ethnobotanical studies analysed here.

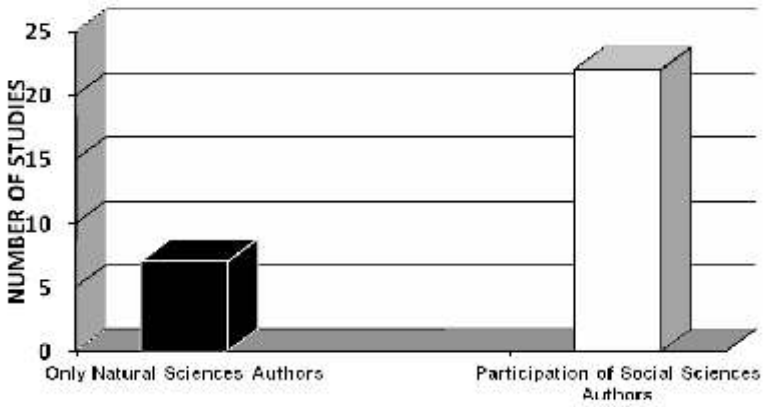

Figure 5. Use of Participatory Techniques in the Ethnobotany studies performed in Peru Ordered by team composition and RPE index>0.5.

In the case of the indicator "Academic contribution", the main part of the studies with an RPE index score > 0,5 were contributors of a giving academic material, product of the research work (see fig. 3). The collection of plants for herbaria is the registered item more common. However, following the scientific norms for the acceptance of specimens in herbariums, the authors should be having a voucher number of each specimen. Then, if the voucher number is not mentioned in the paper, these studies are not considered academic contributors.

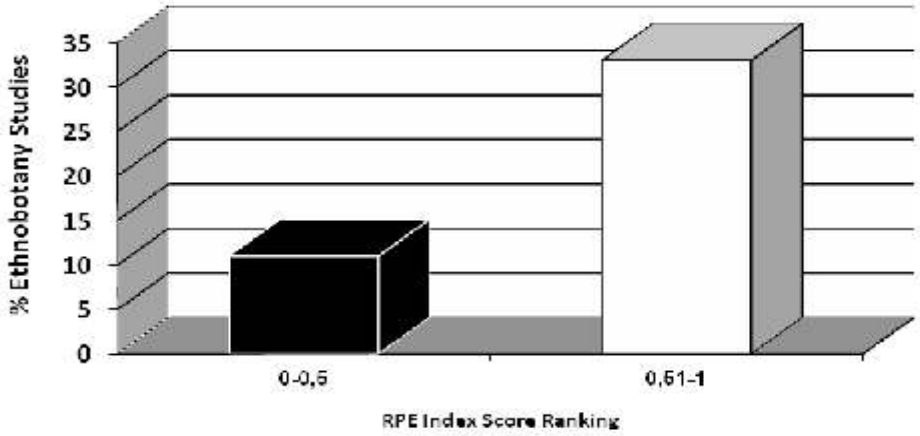

Figure 6. Percentage of Ethnobotany studies which includes the use of participatory techniques by RPE Index score ranking.

The indicator "Support Institution" shows low values as well. It is because the maximum number of institutions that support a research within the universe of analysed studies is used as reference to calculate this indicator. Thereby a few of studies with several support institutions serve to the visualization of the concentration of financial resources. For instance, the main parts of the ethnobotany studies wherein Peruvian scientists participate do not count with data about financial support institutions (fig. 7).

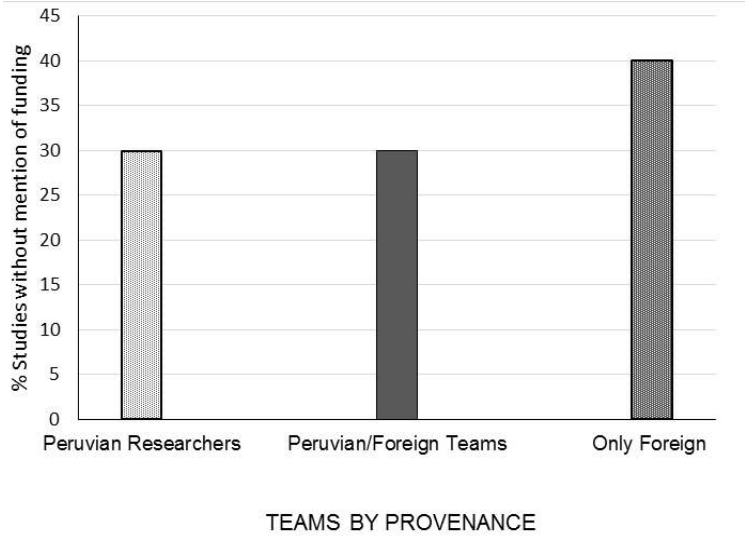

Figure 7. Percentage of Ethnobotany studies without funding mention Ordered by author provenance.

Is noted that 74% of the analysed papers contain information about the source of their funding support, and the funding support may be estimated with an average of near of two funding institutions per each research. The relationship funding-performance is slight, because only 51% of the studies which exhibit values of a RPE index >0,5, were supported by two or more institutions. (see fig. 8).

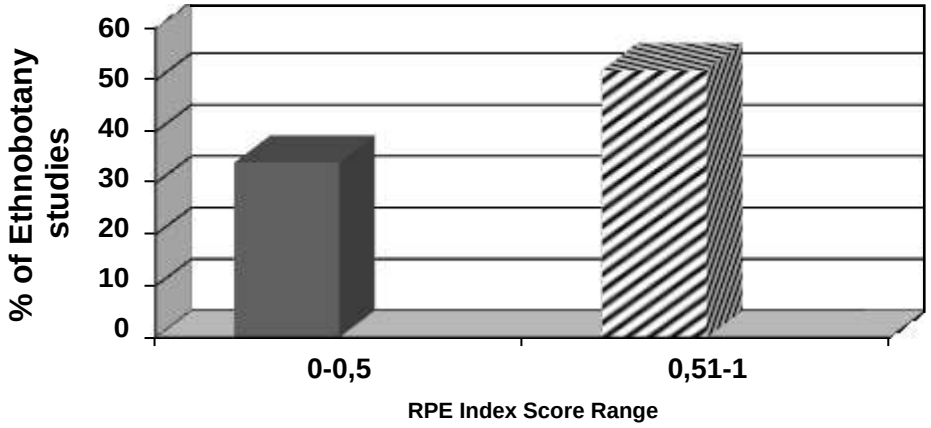

Figure 8. Ethnobotany studies with two or more support institutions by score Range of RPE index.

In the case of the Multidisciplinarity indicator, it show an average value of 0,36 in spite that more of the half of the analyzed studies were performed by research teams. The reason is that only 37% of them were interdisciplinary teams. In 92% of the studies with scores of the Multidisciplinarity Indicator >0,75 was verified an RPE Index >0,5. In other words, there is an evidence of a relationship between the multidisciplinary character of the teams and the research performance in the ethnobotanical studies performed in Perú (fig. 9).

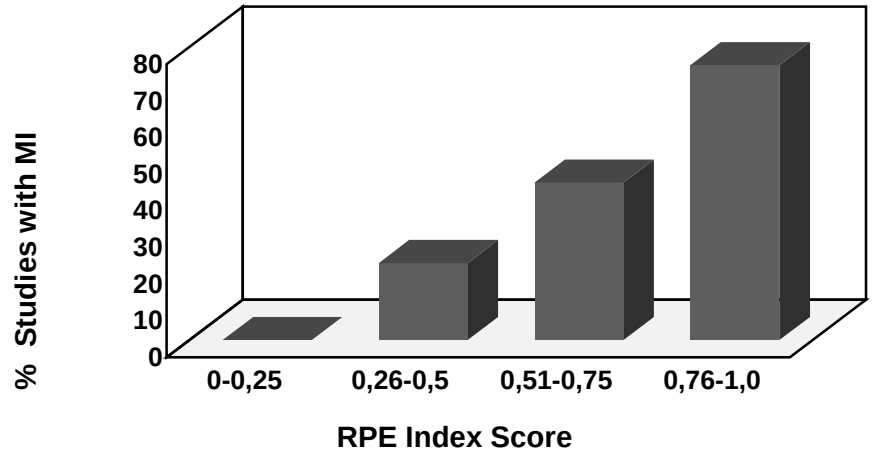

Figure 9. Percentage of Ethnobotany studies with multidisciplinarity indicator values > 0,75 by score range of reached RPE index.

In the case of the indicators "Researcher experience indicator" and "Ethnobotany specialization" both exhibit an value with an average > 0,93. It means that the majority of researchers involved in ethnobotanical studies driven in Peru attained a good professional level. The researchers with formation in biological sciences are the predominant among the scientific leaders in the all studies. However, the studies with best performance (RPE index > 0,75) have as research leaders primarily to scientists with formation in social sciences and Pharmacology. (see fig. 10).

Finally, the indicator of scientific communication presents the higher average number from the all indicators. It means that almost all studies were published in a journal peer reviewed. The studies were published mainly in foreign journals, with predominance of *The Journal of Ethnopharmacology, Economic Botany* and the open journals *Ethnobotany Research and Applications* and the *Journal of Ethnobiology and Etnomedicine*. However, none study with a RPE index score >0,75 was published in a Peruvian journal (Fig.11). It is noticeable because, approximately 16% of the analysed studies were published in Peruvian journals, many times dependent from local universities.

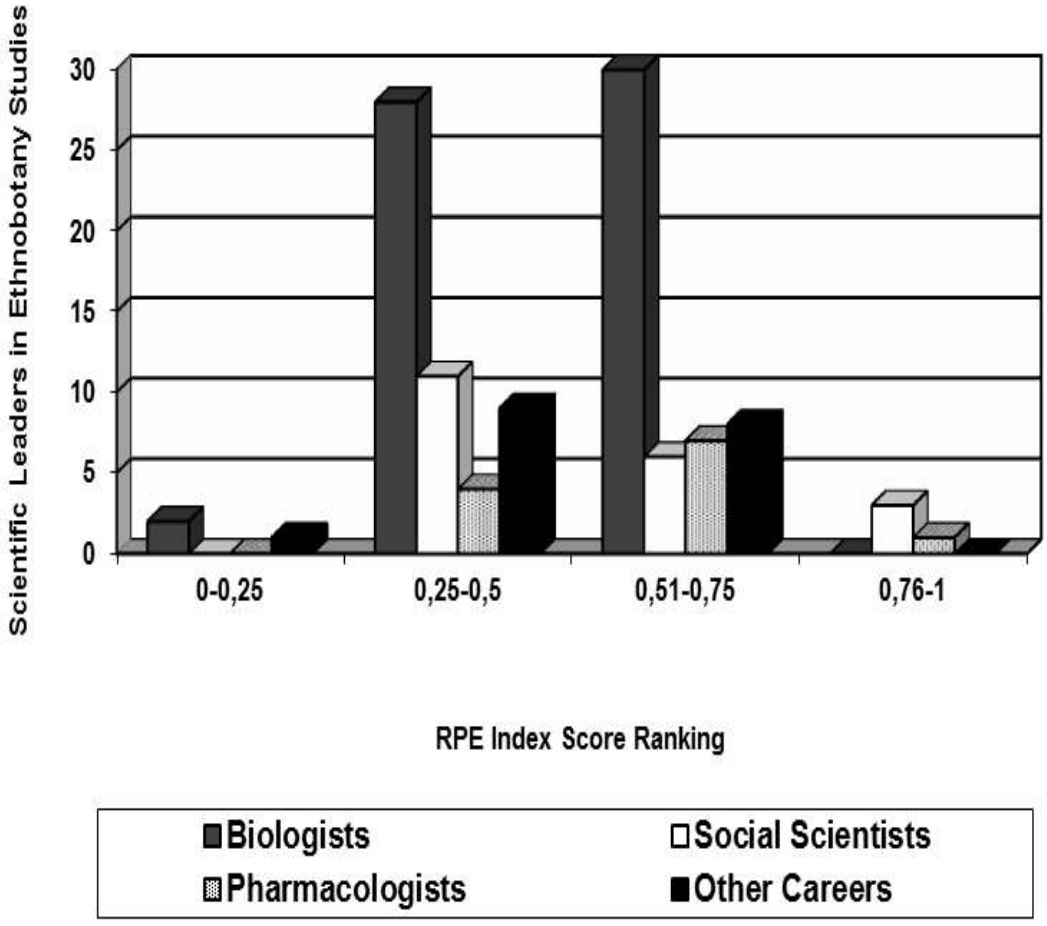

Figure 10. Scientific Leadership of the Analysed Ethnobotany studies by RPE Index Score Ranking.

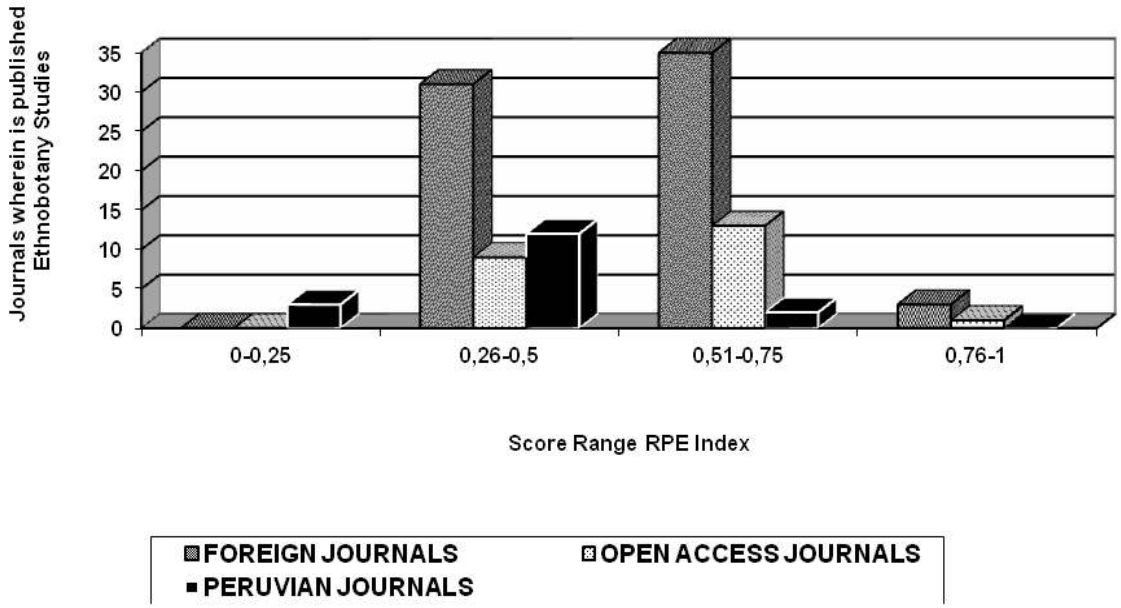

Figure 11. Journals wherein analysed Ethnobotanical studies were published during 2000-2013 by provenance and RPE Index Score Ranking.

DISCUSSION

According to the results, 50% of the analysed studies attained a RPE index score > 0,5 while an only study conducted entirely by Peruvian researchers was valued with this score. Following the criteria used in this work only those ethnobotanical studies with a score >0,5 would be considered with well research performance. The observation of accumulated scores of RPE index reveals that the majority of studies count with experienced researchers, with specialization in ethnobotany or allied fields, and with their results published in peer reviewed journals. These results are given by the indicators of experience on ethnobotany research, the indicator of specialization in ethnobotany and the scientific communication indicator. The three indicators mentioned are linked in ethnobotany research according to Albuquerque *et al.* (2011). Effectively, these authors find out that the achievement of an advanced academic grade and the prestige of authors can influence the successful for to publish studies on ethnobotany in peer reviewed journals. In our case, the prestige is understood as the prior participation in ethnobotany studies while the academic position of the ethnobotanists is interpreted as a specialization in ethnobotany.

The studies conducted by Peruvian researchers could be qualified as of low performance. Some of these studies were published in Peruvian journals, or some tasks not were attained such as scientific contributions, prior consent from studied human group or funding support.

Notwithstanding, the indicator of academic contribution, the prior consent indicator, the multidisciplinarity indicator, and the support indicator are identified too as those that contributes with the best performance in the studies with RPE index scores > 0,5.

The results show that 76% of the studies with

well performance made an academic contribution derived of the ethnobotany research performed in Peru. Those contributions mainly consist of voucher specimens deposited in herbariums. According to Cunningham (2001), the plants collected in tropical and sub-tropical countries which exhibit high diversity do not count with sufficient records of their local flora. For then, the botanical inventories increase the scientific knowledge about the plants and their collections are a scientific contribution. Moreover, the voucher specimens reach importance in ethnobotany because its botanical data should be correlated with the local knowledge about plants to elicit new ethnobotanical knowledge, or could be used as reference specimens during the data collection with aid of the participants (Martin 1995). The problem here is that the plant collection is mentioned in some papers qualified with a RPE index $\leq$ 0,5 but no voucher numbers were included within. It may be interpreted as a no use of herbariums to deposit the gathered plants or that the collected material has not quality to be deposited in a herbarium. In any case, it does not contribute with the science advance because this material is not accessible for other researchers and is unusable with scientific purposes.

The prior consent indicator is too related with the quality of an ethnobotany research. In this sense, MacClachtey (2006) refers that when a manuscript without a prior consent of informants is submitted to journals; it is frequently rejected or could suffer a delay in their publication. Through the prior consent indicator is showed if the right of peoples under study to participate in the ethnobotany research is respected. Apparently, these rights are not taken into account by the majority of ethnobotany researchers whom has publish studies performed in Peru during the last years. In spite of them, 74% of the studies with best performance (RPE index >0,5) obtain the prior consent inform from their informants. But in many etnhobotanical studies with an RPE index score < 0,5 the prior consent inform are not mentioned. It could be explained in part because the researchers have been not leaving this procedure recognized by the professional associations as of obligatory fulfillment and specified in their ethic codes. At respect, see for instance the International Society of Ethnobiology Code of Ethics (ISE 2009), or the guidelines of professional ethics of the Society for Economic Botany (SEB 1995). In the case of the Peruvian biologists, the professionals most frequently involved in the ethnobotany research at Peru, their ethic code (Código de Ética del Colegio de Biólogos del Peru) (CBP 2013) not contain references about the implications of the collection of local knowledge about organisms. For Rosenthal (2006), the ethnobotanists are viewed by many indigenous communities in Latin America, with a mixture of suspicion and unrealistic expectations as suppliers of drug companies. It would be a barrier to negotiate the prior consent from the local peoples, and a reason to justify a low score of the prior consent indicator in some studies analyzed.

At general level, the results show that the studies with a RPE index > 0,5 were carried out by teams more diverse in their composition because the multidisciplinarity indicator reaches scores > 0,75. It indicates a relationship among well performance and multidisciplinarity in the research teams. This indicator must be named more properly indicator of interdisciplinarity because according to the definition of Nicolescu (2011), the interdisciplinarity implies the transference of methods from some discipline to another discipline, enhancing and overlapping the frontiers of each field. It is occurs with the botany and ethnography methodologies whose are adopted by scientists of different disciplines to made science in ethnobotany. In spite of the further essays to measure the interdisciplinarity mentioned in the methodology of the present work, there is

not an adequate indicator to measure interdisciplinarity in a country like Peru. While the anthropologists and botanists lead the ethnobotany research in the United States, in Peru have been physicians as Fortunato Herrera, Fernando Cabieses, Carlos Ostolaza or biologists as Juana G. Infantes, Emma Cerrate, Joaquina Albán, María de los Angeles La Torre, Rosa Urrunaga or Aldo Ceroni, those which are considered the most important researchers in ethnobotany. Then, the indicator of Multidisciplinarity does not discriminate between social and natural sciences, only among different disciplines in the same team. As is noted, the collaboration between scientists from social and natural sciences is more intense in teams composed by foreign scholars, but the social sciences academics remain as a minority into these teams (see the studies of Odonne *et al.* 2013, or Valadeau *et al.* 2009).

The results shows that more of 50% of the studies considered with best research performance (RPE index > 0,5) were supported by two or more funding institutions. As was exposed in the methodology, the funding support may be critical in ethnobotanical studies due to the urgency of count with logistics for to travel to the study site. For instance, based in its experience in Peruvian Amazonia, Pitman (2010) explains that the main obstacle to the permanence of the scientists in the research stations at the Peruvian jungle is the high cost of the field work. But the availability of funding is a difference which remains among the Peruvian ethnobotanists and their foreign colleagues. Effectively, in the majority of analyzed studies without funding are involved Peruvian researchers (fig. 7). As Lederman and Maloney (2003) argue, the level of development of research in Latin American countries has been determined by the grade of industrialization. It is precisely a factor which aid to scientists at universities located near to big cities with industry to encounter funds to be used in research (Laudel 2005). It is not the case of Peruvians scientists, whom depend of the foreign funds to made science. According to the ranking SIR Iber 2007-2011 (Scimago Lab 2013), the main part of scientific publications of Peruvian universities are made in collaboration with foreign institutions. The results show that some ethnobotany studies has been performed by teams composed by both Peruvian and foreign researchers (see the works of Lawrence *et al.* 2005, Bussmann *et al.* 2007, Hübschmann *et al*. 2007 Balslev *et al.* 2010, amongst others).

The information provided by the support indicator too aids to encounter a relationship with the scientific production. It is the case of some ethnobotanists whom could be impelled to publish more frequently than others for achieves prestige or to attain funds due to their presence in the scientific community, as suggested Albuquerque *et al.* (2011). In our work was found that 72% of the authors with two or more published articles attained at least a single source of funding for their research. In contrast, no Peruvian researcher is a main author of more of one ethnobotanical study included in the present analysis. Accordingly, newly the Peruvian ethnobotanists would be in disadvantage in relation with the foreign researchers whom have a most great scientific production.

The results indicate that the quantitative indicators of multidisciplinarity and funding support could serve to detect studies with well research quality. In fact, the successful of the collaboration between scientists has been explained based in the interaction among scholars from different disciplines (Sonnewald 2007). Our results reveal that 91% of the studies with a RPE index score >0,5 were made by research teams. This explains the relationship between research performance and scientific collaboration. On the other hand, 73% of the studies with best performance have been receiving funding at least by one

institution, but only 51% of these studies received support of two or more institutions. The last percentage represents the fraction of studies which obtained funding support by a number of institutions over the average of all studies. It does not explain totally the relationship between funding and the performance of the ethnobotany research. However, according with the results, the ethnobotany studies considered with best performance were well supported and exhibit outcomes such as: the publication of their results in a peer reviewed journals, academic contributions to the science, and the scientific production through the interdisciplinary teams. These outcomes would be attained with an adequate funding according to Carayol & Matt (2006).

Our indicator of informant expertise is based in the age data of the informants. The problem coming because the data about the age of the informants are not considered relevant for those studies which are focused in issues as cultural transmission of knowledge (M. Leanaerts pers. Comm.), or when the quality of information is presumably assured with the participation of local experts (for instance, many times used in the studies of Bussmann *et al.* 2007). Another complication is the little sample size, related with a reduced population of certain ethnic groups, as in the case of the work of Jernigan with Iquito people (Jernigan 2012); and when the informants are not available by different reasons, as in the case of the study of Vormisto (2002). In the studies mentioned above, the limitations encountered by the researchers during the survey were explained in their reports. However, other authors do not show relevant data about their informants, which they consider experts. Alexiades (1996) recommend the collection of data from informants about gender, sex, age, life history, ethnic group, status in the studied community and data about their practices if is a healer. Additionally, some complementary information as the living time in the study site, the number of plants used by her/him, their fluency in an indigenous language, or evidences of their knowledge such as their participation in prior studies might be obtained by the researchers to confirm the expertise of informants. Unfortunately, many ethnobotanists omitted some of the data mentioned above in their articles.

If the age was not used as a criterion to select informants during the use of cultural consensus methodology, the information provided by the collaborators could be biased and may affect the results. The employment of indices such as the use value index could offer erroneous outcomes if the informant has been inexpert in plants knowledge.

The use of children as informants in ethnobotany would be questioned due to their lesser cognitive development (Au & Romo 1999). In any case, rural children might serve as informants in ethnobotany after eight years old, when their expertise in categorizing and naming local plants is more evident according with studies performed in rural Mexico by Zarger & Stepp (2004). In the present analysis, only was identified the study of Luziatelli *et al.* (2010), where in rural children with more of ten years old gave information about use and preparation of medicinal plants. Although, the informants below 20 years old are not covered by the indicator of informant's expertise, it would be a reason to modify the age range of collaborators in future studies.

In order to obtain the pertinent information, the indicator of informant's expertise must be used with caution to evaluate knowledge in migrant people. The local knowledge about organisms could be failing because the migrant are out of context. It is the case of Andean families that migrate to the Peruvian coast and exhibit less knowledge about some marine species (Pizarro 2011). In addition to this, the indicator must be applied with reserves to evaluate knowledge in urban descendants from peoples

whom comes from rural zones. In this sense, Atran *et al.* (2004) refers that the local knowledge decline in younger members from societies that turn in sedentary peoples. In these cases, the knowledge about plants could decrease because the traditional species in the culture of these human groups have not ecological salience and the cultural transmission of LK is failed between parents and sons.

In relation to the Google scholar citation indicator, the results do not offer a clear relationship with the RPE index scores. But, is noted that the ethnobotanical studies performed in Peru most cited in Google scholar were authored by foreign researchers and written in English. As Meneghini *et al.* (2008) argue, the publications of Latin America scientists which were published in highly cited journals are undercited in comparison with papers of developed countries. In our study, the top cited paper in Google scholar (GS) was published by Reiner Bussmann and Douglas Sharon (214 citations). Bussmann & Sharon are foreign scientists, as well as the majority of scientific leaders of the analysed studies, but Bussmann is the author with the greater scientific productivity within the all authors of the studies analysed here. Within the ten articles most cited in GS almost all of them were authored by foreign researchers. Besides, many of the authors with more citations in GS are authors which wrote two or more papers on ethnobotany. In similar way, during a review of the ethnobiology scientific production in Peru during 1963 to 2012, the ethnobotany was encountered the field with more articles and citations, but these studies were authored mainly by foreign researchers (Albuquerque 2013). In agreement with these results, there are a relation between the number of citations in GS of some ethnobotanical studies performed in Peru and factors such as the condition of to be a foreign researcher and the effort to publish of the author. Although the use of Google academic as a scientific database has been criticized due to the errors related with the coverage, interfacing, searching and results presentation, it is an useful resource to search citations of articles primarily of non-English journals (Torres-Salinas *et al*. 2009).

CONCLUSIONS

In general terms the ethnobotanical studies performed in Peru and published during the past thirteen years were conducted primarily by foreign scientists, which have a prior experience in ethnobotany research and count with a formation in a related career or was obtained a specialization in ethnobotany. Almost all studies analysed show that the researchers, or at least the scientific leaders of the research teams, are ethnobotanists or professionals with formation in biological sciences. However, the studies with more high RPE index scores were conducted mainly by pharmacologists and anthropologists.

Furthermore, near of 84% of the analysed studies were published in foreign journals, some of them with great audience and quality as *Economic Botany* and the *Journal of Ethnopharmacology*. The publication of studies in these journals allows get the visibility, which is an important attribute of the scientific communication. It would explain the fact that the ethnobotanical studies most cited in Google scholar were published by authors with high productivity in journals peer-reviewed. Other kinds of contribution were the voucher specimens, which were deposited in herbariums at least in 45% of the studies.

The studies with a RPE index score > 0,75 are considered with high performance. However, only 5% of the analysed studies obtained this result and any study conducted by Peruvian researchers succeeded. It implies that, in relative terms, the Peruvian researchers present a low scientific performance

characterized by no funding support, none use of participatory methods in the data collection, prior consent informed not obtained from studied communities and very few materials derived of the ethnobotany studies considered academic contributions.

The results reveal too that the studies with best performance were performed by teams with a greater disciplinary diversity. In spite that the social sciences researchers are a minority in the whole group of researchers, they are distinguished by their leadership of teams which use participatory techniques. By contrast, the biologists remain as the most frequent members in the teams which perform ethnobotany studies in Peru.

The funds used to perform great part of the studies with best performance were provided by two or more funding institutions. These results could be interpreted as an evident relation among the scientific quality of the ethnobotanical studies, represented by an RPE index score >0,5 and the support attained by each study, represented by the number of funding institutions.

In relation to the indicators used in the present study, I conclude that the RPE index is an useful tool to assess many indicators of the research quality of the ethnobotanical studies performed in Peru during the last twenty years in spite of the adjustments which the RPE index requires. The indicator of multidisciplinarity and the support indicator would be considered well monitors of the collaboration between scientists, which is of great concern in the Peruvian context because further ethnobotanical studies with best performance studies has been developed by research teams. In addition, the support indicator could be used to measure the success of the studies which involves Peruvian scientists, whom count with insufficient funds to made science.

The indicator which measures the expertise about plants presents some complications to be monitor of research quality. In this case, the estimation of the expertise on plants of the informants is reduced to the measurement of the age of the participants, when is well known that the local knowledge about plants is governed by further variables such as the environment, the cultural complexity, the ecological and taxonomic salience of the plants, amongst others (Brown 1977, Berlin 1992, Hunn 1999). But the proposal of measure the expertise as a function of the age is reinforced by the fact that the conditions under which adults and elders learned about the management and certain uses of plants will not occur again due to severe changes experienced in the environment and in the cultural patterns of many ethnic groups in Peru (see Hammil & Salick 2003, Mäki *et al.* 2001, Fjeldså & Kessler 1996). Although Godoy *et al.* (2009) argue that a growing of the ethnobotanical knowledge may be occurs as part of the dynamics produced by the socioeconomic change. Nevertheless, this new knowledge emerges as a product of acculturation and this may mask the disappearance of some local knowledge.

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