



Original Article

Assessment of Community Indigenous Knowledge on Traditional Use of *Arthrospira*/
Spirulina Species

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ABSTRACT

Arthrospira/Spirulina has a high content of proteins, pigments, essential fatty acids, vitamins and minerals. In Ethiopia Lake Aranguade (HaraHadho) and Chitu and also in Kenya Lake simbi and nakuru are dominated (almost unialgal population) by *Arthrospira*. This microalga is the major food source for monkeys and the vast flocks of lesser flamingo in the lakes. The objective of the present study was, therefore, to assess and document community indigenous knowledge on traditional use of *Arthrospira species* in Lake Aranguade Ethiopia. Data was collected using structured and semi-structured questionnaire, personal interview, focus group discussion. Questionnaires were designed to collect information across 22 group informants (111 informants) who involved in the study from Gerbichakebele. From all study participants 98 (88.3%) were female and 13(11.7%) were male. Most of the respondents reported that *Spirulina* (thick algal mat) covered the lake during spring season, when there is cloudy air condition. All study participants said that no needs *Spirulina* for food but, monkeys are the only animal that uses *Spirulina* for food. Cattle also use the water for drinking during shortage of greases. All of the respondents reported that *Spirulina* is important for traditional medicines to prevent lesion and skin scabies for animals and humans. All respondents reported that uses *Spirulina* for house painting and wash their cloth. As a conclusion *Arthrospira* have been used for many purposes by the farmers live around the lake for many years until now. All citizens have a responsibility to participate in the restoration of the lake as well as utilization of the resource wisely.

KEYWORDS: *Arthrospira*, *Spirulina*, indigenous knowledge, Lake Aranguade.

INTRODUCTION

Indigenous knowledge is the local knowledge or knowledge that is unique to a given community or society. It contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities (Warren, 1991). Community indigenous knowledge on traditional use of

Arthrospira species can be unique to a specific country and their culture.

Arthrospira is a photosynthetic, filamentous, spiral shaped, multicellular blue green microalgae. The species grow particularly well in soda lakes (which have high levels of sodium carbonate and sodium bicarbonate) that are astonishingly alkaline (the pH up to 11), in tropical and subtropical regions of the world. *Arthrospira* is an alkaliphile (adapted to alkaline conditions), a thermophile (adapted to

extremely hot conditions), a halophile (adapted to salty water) and an extremophile (adapted to conditions too extreme for most life forms). *Arthrospira* uses sunlight and CO₂ to grow (autotrophic) or organic compounds (auxotrophic) or both (autoauxotrophic). *Arthrospira* is reviewed to have a high content of proteins, pigments, essential fatty acids, vitamins and minerals (Belay, 2008 and Mani *et al.*, 2008). Ancient Mexicans were the first people in the world to use *Arthrospira*. In 1521, *Arthrospira maxima* used to be harvested from Lake Texcoco, dried, and sold for human consumption in Tenochtitlan (Mexico City) (Ciferri O., 1983). *Arthrospira* also possesses other biological functions such as antiviral, antibacterial, antifungal, and antiparasite activities (Khan *et al.*, 2005). It is also used in

the diets of fish and poultry and even sold as a healthy food (Richmond A., 1990).

According to Talling *et al.* (1973) and Melack (1979), in Ethiopia Lake Aranguade (HoraHadho) and Chitu and also in Kenya Lake simbi and nakuru are dominated (almost unialgal population) by *Arthrospira*. This microalga is the major food source for monkeys and the vast flocks of lesser flamingo in the lakes. The aim of the present study was, therefore, to assess and document community indigenous knowledge on traditional use of *Arthrospira species* in Lake Arenguade Ethiopia.

MATERIALS AND METHODS

1. The study area description

Lake Arenguade is member of string of volcanic explosion crater lakes that are found in main Rift Valley of Ethiopia. The lake is located at South East of Addis Ababa in Ada'a distinct of East Sheoa Zone near Bishoftu town. Lake Arenguade is situated is located at 7 km South west of Bishoftu town in Gerbicha kebele at latitude of 8° 41' N, longitude 38° 58' E and an altitude of 1900 meter above sea level. Lake Arenguade was so named (Arenguade means green in Amharic language) after the green

coloration of surface waters by the filamentous blue-green alga *Arthrospira/Spirulina*. Local people use the lake for laundry and ablutions, watering their cattle at the fresh water springs feeding the lake (Seyoum M. *et al.*, 2006) and even encourage their cattle to drink the lake water believing that the *Arthrospira/Spirulina* water has some therapeutic effects and compensates for some lack in the diet of their cows (Elizabeth K., 1997).

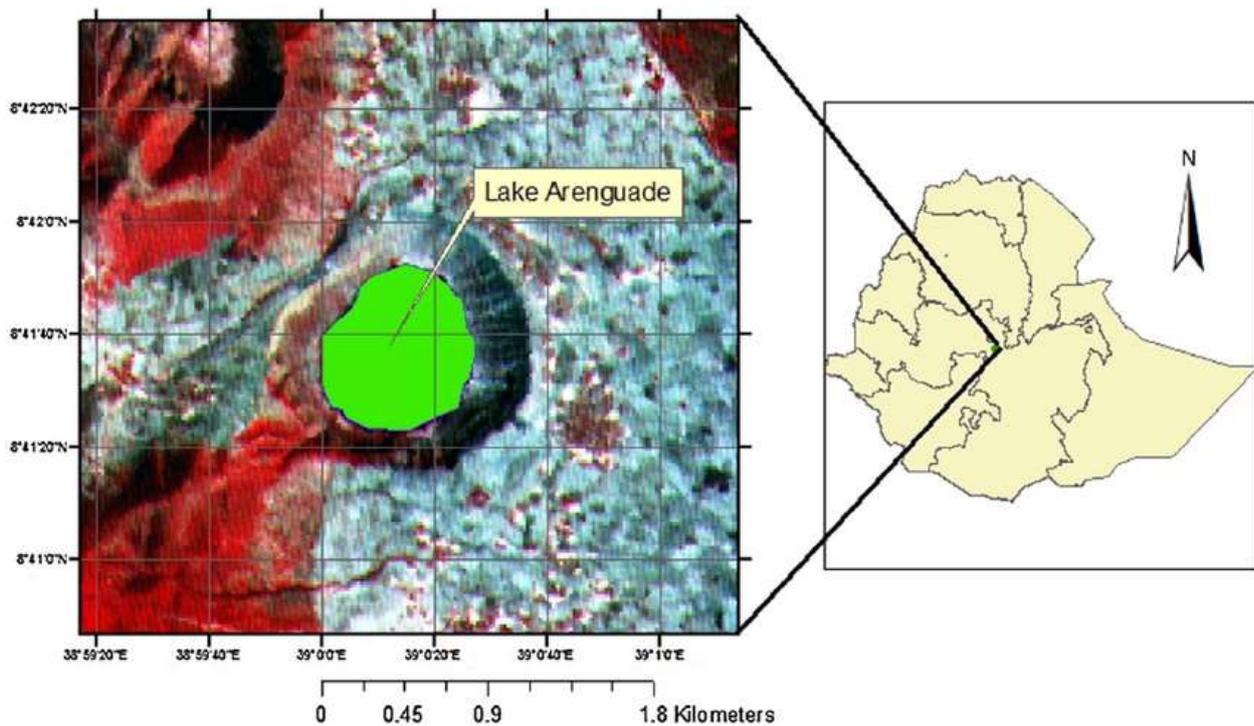


Fig 1. Lake Arenguade (Lake Haro Hadho) in Ethiopia (source: - Research gate)

2. Selection of participant households

The study was conducted in South Oromia, Ethiopia in Arenguade Lake Gerbicha Kebele. Elders (whose age is 18 and above) were purposively used with different socioeconomic back grounds in the study and their ages were listed with the help of kebele leaders.

3. Data collection

In order to assess and document the traditional indigenous knowledge of *Arthrospira* species in Arenguade Lake (Gerbicha kebele) Primary data were collected .Then a structured questionnaire was designed to collect information across 22 group informants (111 listed elder informants). Interviews were done in the kebele and the questionnaires were filled. The questionnaires mainly focused on informants Socio demographic characteristics and experience on the traditional knowledge

about the behavior of the lake, season *Arthrospira* mostly available use and harm of *Arthrospira* to humans and animals currently in previous time and community participation to keep the species to future generation. Simple random sampling was used to select and interview the target of 22 group informants' adult individuals from the purposively selected 696 total elder house hold heads.

RESULT AND DISCUSSION

1. Socio-economic characteristics of the study participants

The study was conducted in Oromia region particularly Bishoftu zuria district, around the lake Halo area. A total of 111 adult individuals were participating in the study. From all study participants 98 (88.3%) were female and 13(11.7%) were male. 39(35.1%) of the population involved in the study was the age in

between 51-75 years old, 28(25.2%) of the population involved in the study was the age in between 26-35, 27(24.3%) of the population involved in the study was the age in between 36-50 while the rest of 9 (8.1%) were the ages less than 25 years old. With regard to educational background most of the study participants 57 (51.4%) were illiterate, 24(21.65%) study

participants were completed primary school, 26(23.4%) study participants were completed secondary school, the remaining study participants were completed preparatory school. In relation to ethnicity 32.4% of the study participants were Amhara, 0.9% participants were Gurage and the rest (66.6%) of the study participants were Oromo (Table 1).

Table1. Socio demographic data

			%
sex	male	98	88.3
	female	13	11.7
	total	111	
age	16-25	9	8.1
	26-35	28	25.2
	36-50	27	24.3
	51-75	39	35.1
	>75	8	7.2
Educational	illiterate	57	51.4
	Primary	24	21.6
	Secondary	26	23.4
	preparatory	4	3.6
Ethnicity	Amhara	36	32.4
	Gurage	1	0.9
	Oromo	74	66.6

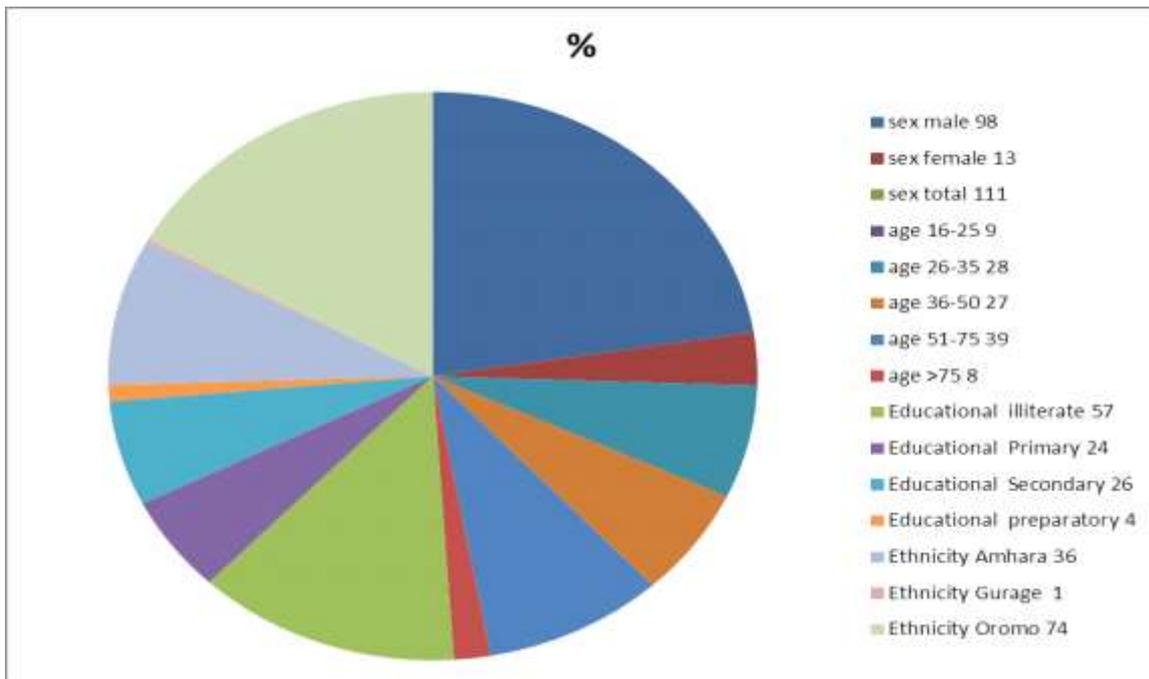


Fig 2: Socio demographic data

2. Period of *Spirulina/Arthrospira* cover the lake

From the study 12 (10.8%) of the respondents informed that *Spirulina* is available in winter season, 99(89.2%) reported that *Spirulina* (thick algal mat) covered the Lake in summer season when there is cloudy air condition (Table 2). During rainy season until October the color of the lake water change from muddy to blue

green or green due to algal growth this is due to the availability of nutrient in the lake become increased and also the salinity. However during summer season death and decay of algae coupled with high bacterial density and increase rate of water evaporation it turns it to light brown to brown finally to dark brown color (Sharma B., 2013).

Table 2: Seasonal variation for coverage of *Spirulina/Arthrospira*

no	Seasons	Lake color	Number of respondents	%
1	Winter(December-may)	green	12	10.8
2	Summer(June-November)	green	99	89.2

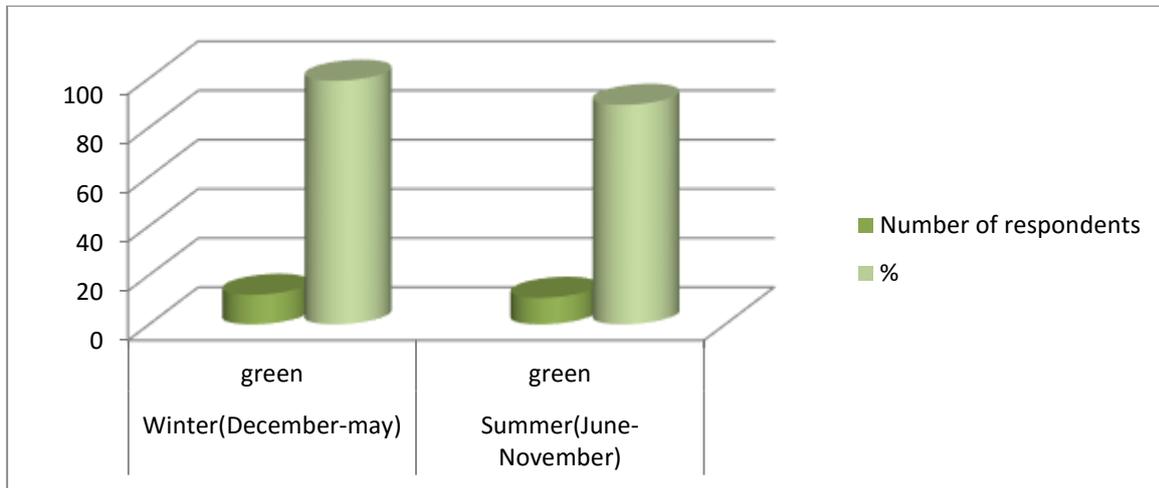


Fig3:Diagram of seasonal variation for coverage of *Spirulina/Arthrospira*

3. Farmers how traditionally identify *Spirulina/Arthrospira*

In the study 9% of the farmers live around the lake said they identify *Spirulina* by its green color and they called it algae. Around 22.5% of the respondents said this *Spirulina* looks like thick algal mat (baked bread) when it becomes cloudy. (68.5) the respondents said that *Spirulina* is the green floating thing on the lake (Table 3). This is supported by previous research of Elizabeth (1997), *Arthrospira* often forms thick algal mats. *Spirulina* is a photosynthetic, filamentous non-differentiated,

spiral-shaped, multicellular cyanobacteria that grow naturally in warm climates (Sa'nchez *et al.*, 2003). According to Vonshak and Tomaselli, 2000 the main morphological feature of *Arthrospira* is the patterned arrangement of its multicellular cylindrical trichomes in an open helix. The free floating filaments of both *Spirulina* are densely granulated at the cross-walls because of the presence of gas vacuoles (aerotopes), but those of the latter species display a more regular disposition of this granulation(Mazo, V. and Gmshinski, I., 2004).

Table 3: Farmers traditionally identify *Spirulina*

<i>Spirulina</i> Morphology	Number of respondents	%
Green thing	10	9.0
like baked bread(thick algal mat)	25	22.5
Green floating thing on the lake	76	68.5

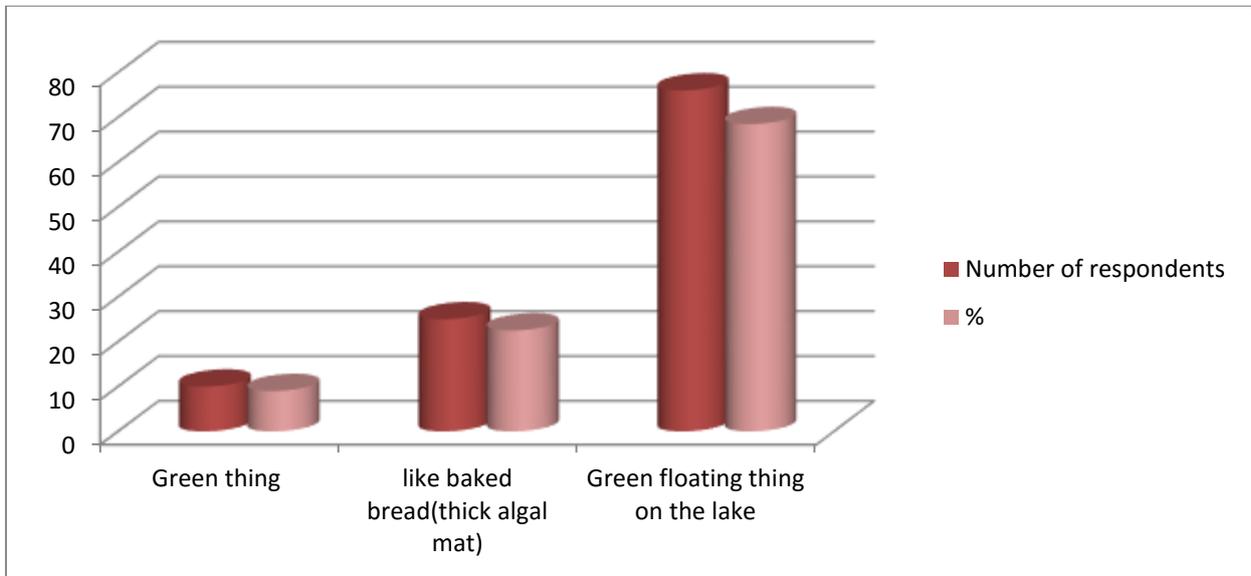


Fig 4: Farmers traditionally identify Spirulina

4. Farmers how frequent use *Spirulina* for food

61.3% of the respondents reported that monkeys use *Spirulina* for food and 38.7% of the farmers informed that cattle also use the water for drinking. But all of the respondents reported that no one use *Spirulina* for human consumption (Table 4). *Spirulina* has long been used as a dietary supplement by people living close to the alkaline lakes where it is naturally found. *Spirulina* has been used as a complementary dietary ingredient of feed for fish, shrimp and poultry. Among the various species of *Spirulina*, the blue green alga *Spirulina platensis* has drawn more attention because it shows a high nutritional content characterized by 70% protein content and by the

presence of minerals, vitamins, amino acids, essential fatty acids etc. (Campanella L, Crescentini and Avino P., 1999). *Spirulina* is consumed in many different countries such as Germany, Brazil, Chile, Spain, France, Canada, Belgium, Egypt, United States, Ireland, Argentina, Philippines, India, Africa, and other countries, where public administration, sanitary organisms and associations have approved human consumption. (Henrikson R.,1994). It is a major food item for lesser flamingoes (*Phoeniconaias minor* Geoffroy (syn. *Phoenicopterus minor* Geoffroy)) in Lake Arenguede (Talling and Lemoalle, 1998). In Japan *Spirulina* is also used in animal feed and extraction of pigments for use in food (Belay et al., 1997).

Table 4:Frequently use of *Spirulina* by farmers with respects to their nutritional significance

respondents		Used for
number	%	
68	61.3	animal food
none	-	human food

43	38.7	drink the water for animal
none	-	drink the water for human

5. Farmers how frequent use *Spirulina* for traditional medicine

In the present study, 36.0% of the respondents informed that they use *Spirulina* to prevent animal skin scabies or have antifungal activity for animals and humans, According to Mohammed et al., 2014 it was found that *Spirulina maxima* were the most potent acting against the pathogenic fungus. *Spirulina* possesses antiviral, antibacterial, antifungal, and antiparasite activities (Khan et al., 2005). 40.5 % of the respondents confirmed that *Spirulina* used as ant parasite and used as antimicrobial for enteric bacterial infection. For centuries it has been known that *Spirulina platensis* is a very promising source of anti-bacterial, anti- fungal, anticancer, anti-viral, anti- plasmodial etc. It has been used as a traditional medicine for many diseases.

Arthrospira have displayed significant antibacterial activity against *Vibrio* strains, *Streptococcus pyogenes* and/or *S. aureus* (Kokou F. et al., 2012) and (Najdenski H. et al., 2013). Purified C-phycoyanin from *S. platensis* markedly inhibited the growth of some drug resistant bacteria: *E. coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *S. aureus* (Sarada D. et al., 2011). 7.2 % of the respondent said that they used the lake water for fattening of their animals. According to Mabrouk R. et al, 2014 *Spirulina* increased body weight gain, total WBC count, plasma globulin, vitamin A and reduced glutathione concentration while decreased liver enzymes activities, cholesterol, glucose and plasma malondialdehyde concentration. 16.2 % of the respondents reported that it is used for placenta removing (Table 5).

Table 5:Frequently use of *Spirulina* by farmers with respects to their medicinal significance

no		Used for	Number of respondents	%
1	Animals and humans	Prevent animal skin scabies (used as antifungal) Prevent skin lesion	40	36.0
2	Cows and women	For placental removing	18	16.2
3	animals	For fattening of animals	8	7.2
4	animals	used as anti-parasite and used as antimicrobial for enteric bacterial infection	45	40.5

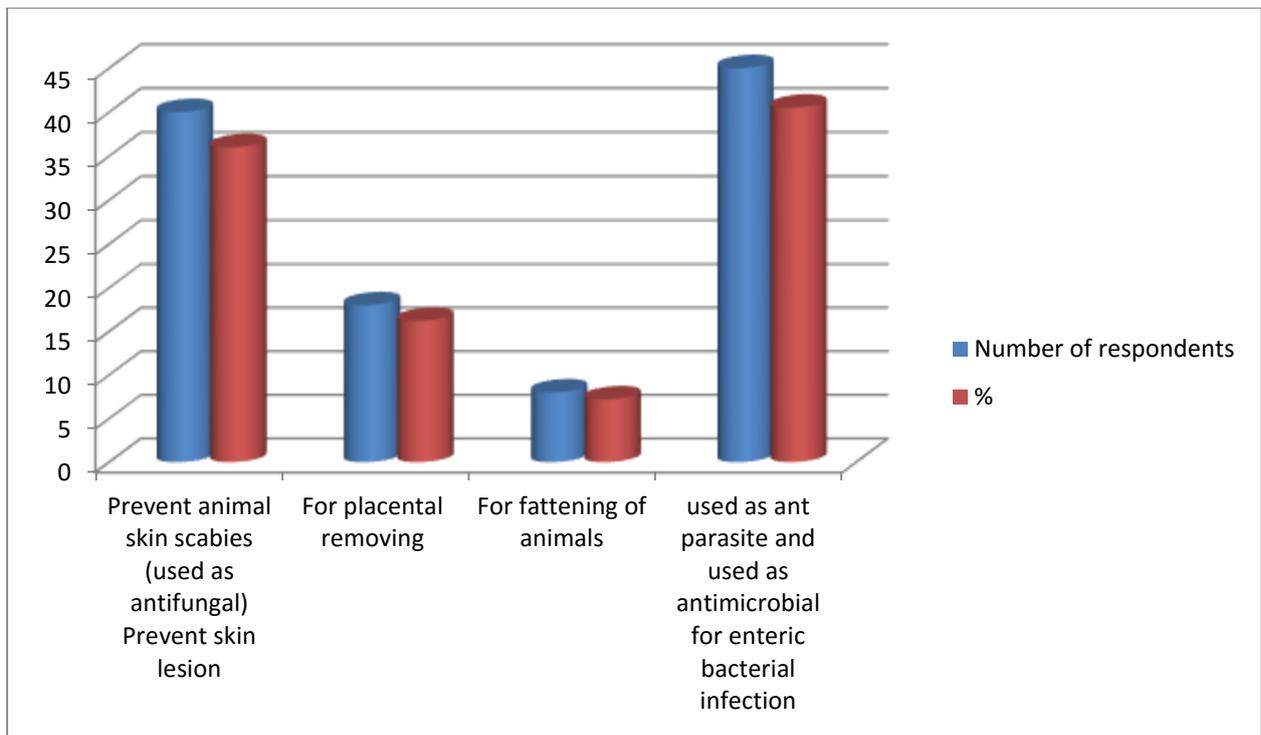


Fig5: Frequently use of *Spirulina* by farmers with respects to their medicinal significance in flochart

6. Use of *Spirulina* for house painting, coloring hairs and for sanitary purposes

30.6% of the respondents said that they use *Spirulina* for house painting, 29.7% of the farmers reported that they decor their hats using

Spirulina, 15.3% of the farmers informed that they also use *Spirulina* for coloring of animal and human hairs, 24.3% of the respondents said that they use the lake having *Spirulina* for washing clothes (Table 6).

Table.6 Use of *Spirulina* for house painting, coloring hairs and for sanitary purposes

number of respondents	%	Used for
34	30.6	house painting
33	29.7	hat decoration
17	15.3	coloring human and animals hairs
27	24.3	washing cloth (use as detergents)

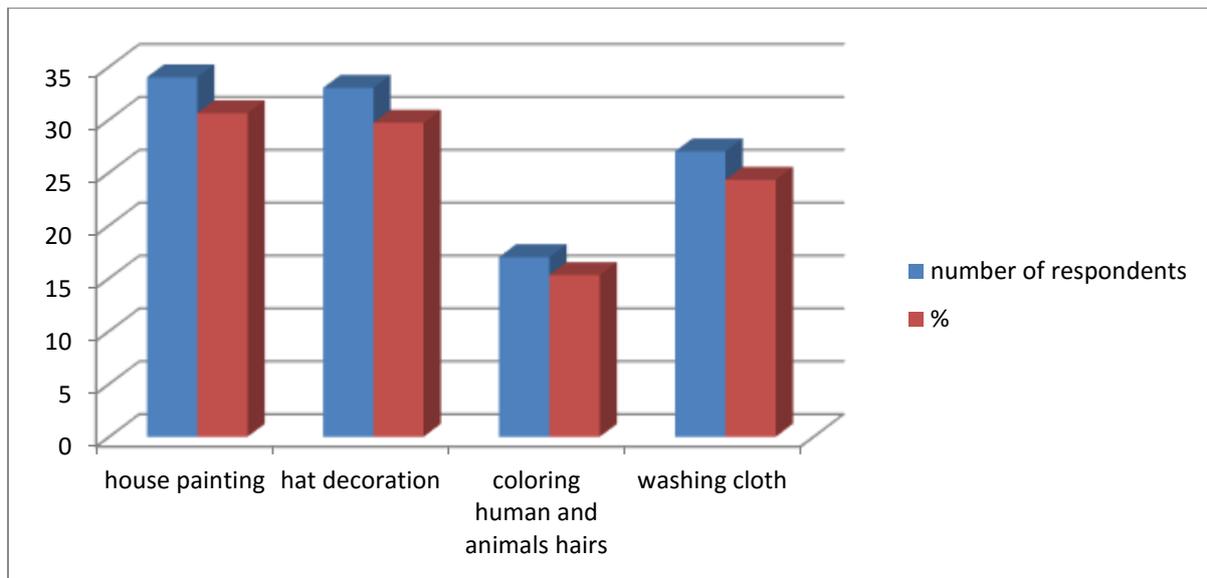


Fig 6: Use of *Spirulina* for house painting, coloring hairs and for sanitary purposes in flochart

7. Factors for the dilution of *Spirulina* in Lake Arenguade

In the present study, 27.9 % of the respondents said that *Spirulina* dilution was due to the inflow of water (flood), 32.4 % of the respondents reported that Seismic explosion (1971) was the main factor for the dilution of *Spirulina* and change in the limnological features of Lake Arenguade, 28.8 % of the farmers informed that human interference (deforestation) was also the main factor for the dilution of *Spirulina* as well as the change of lake feature and 10.8 % said animal interference was also the factor for dilution of *Spirulina* (Table 7). The recent dramatic changes in the limnological features of Lake Arenguade reported by Belachew (2010) are not easily

explicable as activities of local people that could have led to the observed changes in the lake’s water chemistry are unlikely. Lake Arenguade was deliberately selected as a standing shot site for deep underwater detonation of seismological exploration forseveral years (Klemperer and Cash, 2007). Burkhardt and Veas (1975) carried outdeep underwater seismic explosion in 1971, detonating 1100 kg ofexplosives in Lake Arenguade. The facts that Lake Arenguade has undergone considerable dilution are often associated with inflow of more dilute spring waters (Dror et al., 1999), underground seepage (Isiorho et al., 1996), flood or diversion of rivers (Welch and Patmont, 1980).

Table.7. Factors for the dilution of *spirulina*/*Arthrospira* in Lake Arenguade

Factors for dilution of <i>Spirulina</i>	No. of respondents	%
Inflow of water (flood)	31	27.9

Seismic explosion (1971)	36	32.4
Human interference (deforestation)	32	28.8
Animal interference	12	10.8

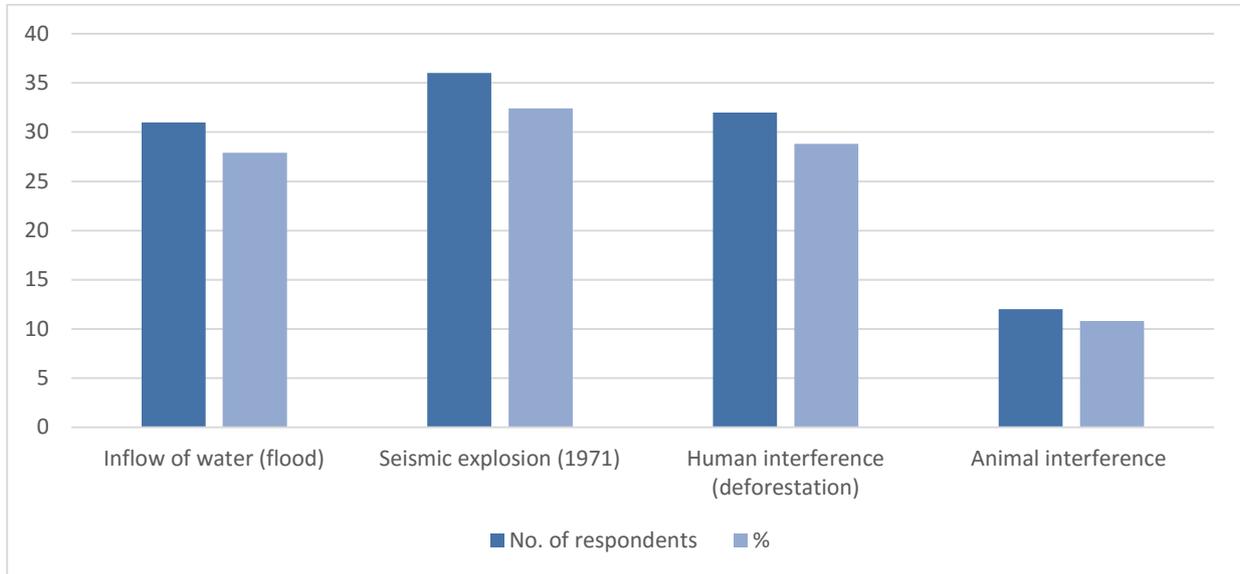


Fig7:Factors for the dilution of spirulina/Arthrospira in Lake Arenguade in flochart

CONCLUSION

In conclusion from the above results it can be concluded that *Arthrospira* or *Spirulina* covered Arenguade Lake or form algal mats during rainy season when the weather is cloudy and *Spirulina* is used for monkey for food and the farmers use this *Spirulina* for sanitary purpose, for dyeing their and their animals hair as well as to decor houses and hats. And also *Spirulina* was used by farmers as a traditional medicine such as prevention of animal skin scabies (used as antifungal) and prevention of skin lesion, used as ant parasite and used as antimicrobial for enteric bacterial infection, for placental removing and for fattening of animals. Researchers and the Keble farmers must collaborate for the restoration of the lake to solve the cause of environmental degradation.

We must acknowledge all stakeholders with different interests and promote sustainable utilization of the lake and we must create awareness for the farmers how they use this resource wisely without damaging (when they use for sanitation and for cattle drinking) the lake. We need to develop workable strategies of protection and utilization of this precious resource.

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