Eth. J. Sci. & Technol. ISSN 1816-3378

Ethiopian Journal of Science and Technology

Volume 5 Number 2
April 2008

Bahir Dar University
Bahir Dar, Ethiopia

Ethiopian Journal of Science and Technology

Ethiopian Journal of Science and Technology

Published biannually by the Vice President's Office, Research and Community Services, Bahir Dar University, PO Box 79, Bahir Dar, Ethiopia. Edited and Produced in the Research and Community Services Office, Bahir Dar University.

For further information about Bahir Dar University and the Research and Community Services activities, contact Dr Firew Tegegne, Vice President, Research and Community Services or Dr Fentahun Ayele, Vice President, Information and Strategic Communication, Bahir Dar University. Contact Address: e.mail: infobdu@gmail.com, tel: 251582200137, fax: 251582202025, PO Box 79, Bahir Dar, Ethiopia. Website: www.bdu.edu.et.

Remarks

It is uncustomary to write such a remark in a journal. We opted to write it because we almost started the journal anew, which was interrupted for no less than two years in the wake of institutional transformation. Institutional transformation was in full swing at the time when processing manuscripts was temporarily stalled until a new Editorial Board was reconstituted.

This journal, namely the *Ethiopian Journal of Science and Technology (EJST)*, is one of the journals published by Bahir Dar University. Initially, the title of the journal was *The Ethiopian Journal of Technology, Education and Sustainable Development*, for which two volumes were issued starting in 2002. Then it was renamed EJST, with a new look and design, which had to replace its predecessor and continue from volume 3. After renaming, five issues were out, i.e., volume 3 No. 1 in 2005, volume 3 No. 2 and volume 4 No. 1 in 2006, volume 4 No. 2 and volume 5 No. 1 in 2007.

Earlier the journal was intended to be published biannually under the auspices of the then Bahir Dar University's Research and Publications Office. However, one can notice the irregularities in the timing of issues. The reasons might perhaps include lack of manuscripts submitted or problems in the editorial office. The current issue falls on volume 5, number 2 because No. 1 of this volume was issued in 2007. Over the years, this journal had undergone ups and downs because of organizational and financial predicament.

Following the institutional transformation of the University, the academic community has adopted the idea of creating a research university as opposed to the traditional largely teaching based system that has been the norm for a long time in the past. Currently, expectations run high that the University will craft a vibrant research tradition. The surrounding communities and the entire nation as a whole face multifaceted problems in areas of food security, health, energy, environmental health, and other issues. The University is mandated to contribute its part by solving some of these problems and play a role in advancing science and technology for the good of humanity. It will also work in areas of good governance, cultural and economic development.

The University management is in the forefront and is devoted to lift the spirit of the academic community for research and community services. In contrast to what can be seen in the older and larger Universities in the country, such as Addis Ababa University, Bahir Dar University has elevated the Research and Community Services (RCS) to a Vice President level, which was a sign to the management's commitment for change. The RCS was further strengthened with manpower and resources. Apart from the three senior experts under the Vice President, a coordinator for Graduate Program and Research and Community Services was appointed for each College/Faculty, School and Institute.

Essentially, the research and community services will never materialize solely because of these measures. The experts and the coordinators can only facilitate the smooth running of RCS within the research community. Currently efforts are underway to lay down policy environment (guidelines) for the program, and basic steps such as identifying thematic areas for immediate and long-tem attention.

As a part of the new initiative, the journals are under complete restructuring. The prerequisites for ensuring the reputability of journals are being identified. The requirements for both manpower and resources are under review and there is a general consensus that they will be endorsed. The manuscript review process is envisioned to be one of the finest given the issues under review are addressed. As long as quality research is done and reliable reviewers of manuscripts in each field are identified and put in place (there is a firm belief among the academic community that there are) and these reviewers work at full capacity, researchers will no longer be reluctant to publish in these journals because of lack of reputability. As anybody else can do, we expect that with more research and publication, more scientific information passes along segments of society and becomes a dynamic force for change and development.

Call for manuscript submissions

As you may imagine, we have lagged behind in issuing the expected number of volumes. Issues are not out yet for the years 2009 and 2010. To fill the gap, we need as many as 25 quality papers from you. We call for paper submissions, original articles or research reviews, in the different fields of science and technology.

Contents

		Page(s)
Performance Stability Analysis of Potato Varieties under Rainfed and Irrigated Potato Production Systems in Northwestern Ethiopia	***Yigzaw Dessalegn, Fentahun Mengistu and Tesfaye Abebe***	**90-98**
Biologically Active Compounds of Plant Foods: Prospective Impact on Human Health and Dilemmas Associated with these Compounds	***Shimelis Admassu***	**100-112**
Spectral Psychoanalysis of Speech under Strain	***Durga Prasad Sharma, Prathap M and Solomon Tadesse***	**114-123**
Design of a Fuzzy Rule Base Expert System to Predict and Classify the Cardiac Risk to Reduce the Rate of Mortality	***N Nalayini***	**124-135**
Performance Analysis of Throughput at Bahir Dar University Local Area Network (LAN)	***M Prathap and E Chandra***	**136-141**
Techniques and Assessment of Small Business Capital	***S Raja Narayanan and D Arthi***	**142-145**
Motives for *Labeobarbus* Fish Species Migration to Gumara River, Lake Tana, Ethiopia	***Miheret Endalew Tegegne***	**146-157**

Guide to Authors	**158-160**

Eth.J.Sci & Technol. 5(2):90-98, 2008 ISSN 1816-3378

Performance Stability Analysis of Potato Varieties under Rainfed and Irrigated Potato Production Systems in Northwestern Ethiopia

Yigzaw Dessalegn[1*], Fentahun Mengistu[1] and Tesfaye Abebe[2]
[1]*Amhara Region Agricultural Research Institute, PO Box 527, Tel. 058-220-6400, Bahir Dar*
[2]*Adet Agricultural Research Center, PO Box 8, Tel. 058-338-0237, Adet*
[*]*Corresponding author: yigzawdessalegn@yahoo.com*

Abstract
In Ethiopia, farmers cultivate potato both in the rainy season under rainfed condition and the dry season using irrigation. Despite the variation in climatic condition and production constraints between the two systems, farmers grow the same variety both in rainfed and irrigated potato production systems. Moreover, researchers release improved varieties only based on performance under rainfed production system. Therefore, the objective of this study was to assess the stability of improved potato varieties across the two potato production systems. Nine potato varieties were evaluated using randomized complete block design with three replications under irrigation and rainfed conditions for two consecutive years at Adet Agricultural Research Center, northwestern Ethiopia. Results revealed that improved varieties performed better in the rainfed production system than the irrigated production system. In addition, there was no stable variety in both production systems. Zengena, CIP384321.3, Genet, Wochecha, Guasa, Tolcha and Menagesha had regression coefficients higher than unity indicating that these varieties prefer favorable condition (rainfed potato production system). The local variety and Awash had regression coefficient less than unity indicating their response to the unfavorable condition (irrigated potato production system). This depicts the relevance of fostering independent variety selection program for each potato production system. However, currently varieties such as Zengena and Guasa can be recommended for both production systems.

Key words: Potato; variety; yield; rainfed; irrigation; stability; Ethiopia

1. Introduction
Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops grown in the high and mid altitude areas of Ethiopia. It serves as food and cash crop for small scale farmers, occupies the largest area compared to other vegetable crops and produces more food per unit area and time compared to cereal crops. In 2001 E.C., 0.94 million tons of potato tuber was produced nationally from 164 thousand ha of land (CSA, 2003). The Amhara National Regional State contributed 36.1% of the annual national potato production. However, the regional average potato tuber yield (4.8 t/ha) is less than the national average yield (5.7 t/ha) (CSA, 2003). Factors such as late blight (*Phytophtora infestans*) and bacterial wilt (*Pseudomonas solanacearum*) infections, poor crop management and shortage of adaptable and high yielding varieties contributed to the low productivity of potato in the region (Tesfaye and Yigzaw, 2008).

In Ethiopia potato is produced in the rainy season under rainfed condition and dry season using irrigation. In 2002, the irrigated potato production system contributed 58.7% of the annual potato tuber produced and 76.8% of the total area of land planted with potato in the country (CSA, 2003). Likewise, in the Amhara National Regional State, irrigated potato production system contributed 84.2% of the area and 65.5% of the annual potato production. Although irrigated potato production system contributed the lion's share both in the country and the region, its productivity (3.7 t/ha) is lower than the rainfed (10.5 t/ha) system (CSA, 2003). This could be due to differences in climatic

conditions and production constraints of the two production systems. Furthermore, researchers have never released improved varieties for the irrigated potato production system.

The prevailing average monthly maximum temperature is higher in the irrigated potato production system than in the rainfed system. The average monthly minimum temperature is low and causes frost injury to the plant during the irrigated potato production system. Therefore, irrigated potato production is affected both by the prevailing higher maximum and lower minimum temperature compared to the rainfed potato production system (Fig.1). On the other hand, in contrast to the irrigated system, the rainfed potato production system is more affected by late blight.

A temperature of about 20°C is ideal for potato tuber development (Mondal and Chatterjee, 1993). At higher temperatures the plant fails to initiate tuber formation and at low temperatures vegetative growth is restricted by frost (Horton, 1987). Similarly, Mondal and Chatterjee (1993) reported that tuber initiation starts early at lower than at higher temperatures. Besides, the number of tubers produced per plant is higher at lower than at higher temperature. The seed tubers produced at higher temperatures (34°C) are low yielding compared to seed tubers produced at cooler temperatures (7.7^{o}C) (Mondal and Chatterjee, 1993). Therefore, temperature affects not only the yield of treated plants but also the productivity of its progeny.

Bhagsari *et al.* (1988) reported significant variations among potato genotypes in tuber setting and harvest index in different subtropical environments. Despite significant climatic variation between the two systems, potato breeders in Ethiopia select and release improved potato varieties solely based on performance under rainfed condition.

Yield is a complex trait in potato and is generally considered to have low heritability (Lynch and Kozub, 1991). Hence, indirect selection could be useful strategy to bring considerable genetic improvement on potato tuber yield. Therefore, knowledge on the interrelationships of characters with tuber yield seems very important for high yielding potato variety development. Thus, this experiment was conducted to assess the stability of potato varieties and to evaluate the association of different characters with tuber yield under the two potato production systems.

2. Materials and Methods

The performance of nine potato varieties was assessed in this study. The experiment was conducted at Adet Agricultural Research Center using a Randomized Complete Block Design with three replications both under rainfed and irrigated potato production systems for two consecutive years (2001 & 2002). Plot size was 9 m^2 (3 m × 3 m) with a spacing of 75 cm between rows and 30 cm between plants. The trial was planted in the first week of June for the rainfed production system and in the second week of November for the irrigated production system. In both systems nitrogen and P_2O_5 were applied at rates of 81 and 69 kg/ha, respectively. The whole P_2O_5 was applied at planting. The nitrogen split equally into three and was applied at planting, at the first ridging and at flowering. All other crop management practices were applied as recommended.

Number of main stems per plant, plant height, number of tubers harvested per

plot, marketable tuber yield, unmarketable tuber yield and total tuber yield were recorded and subjected to analysis of variance using MSTAT-C statistical software. Genotype x production system and genotype x year interaction were assessed using combined analysis of variance. Duncan Multiple Range Test (DMRT) was employed to separate means. Stability analysis was performed following Eberhart and Russell (1966) method using the model $Yij = \mu I + \beta iIj + \delta ij$. Regression coefficient (bi) was considered as a parameter of response and deviation from regression (Sdi^2) as a parameter of stability (Singh and Chaudhary, 1977). Simple linear correlation was computed to evaluate the association of different traits at different potato production systems.

3. Results and Discussion

In the irrigated potato production system, genotypes were significantly different in number of main stems per plant, plant height, number of tubers harvested per plot, marketable tuber yield, unmarketable tuber yield and total tuber yield (Table 1). Zengena was the tallest in plant height among evaluated genotypes. It also had maximum number of main stems per plant and maximum number of tubers harvested per plot among evaluated genotypes. Marketable tuber yield ranged from 6.7 t/ha to 22.2 t/ha. The lowest and the highest marketable tuber yield were recorded from Wochecha and CIP384321.3, respectively. Zengena and CIP384321.3 were not statistically different in marketable tuber yield. Therefore, Zengena and CIP384321.3 seem promising varieties for irrigated potato production system at Adet. Similarly, Bhagsari *et al.* (1988) reported significant variation among potato genotypes in tuber setting and harvest index while grown in different subtropical environments. Elobu and Osiru (1994) also observed significant marketable tuber yield difference among three heat tolerant potato genotypes under a hot lowland tropical condition of Uganda.

In the irrigated potato production system, the maximum temperature was very high and the minimum temperature was very low. High yielding genotypes had maximum number of main stems per plant, high number of tubers per plant and long plant height. Therefore, genotypes difference in marketable tuber yield under irrigated potato production system could be ascribed to their difference in capacity to initiate tuber at higher temperature and frost tolerance. Likewise, Thornton *et al.* (1996) reported that high temperature retarded vegetative and tuber growth rate in potato. Similarly, Horton (1987) reported that at high temperatures, the potato plant fails to initiate tuber and at low temperature its vegetative growth is retarded by frost. In the rainfed potato production system, genotypes significantly varied in plant height, number of tubers harvested per plot, marketable tuber yield, unmarketable tuber yield and total tuber yield (Table 1). Unlike in the irrigated potato production system, genotypes were not statistically different in number of main stems per plant. Marketable tuber yield ranged from 1.44 t/ha to 33.1 t/ha. The local variety was the shortest and had the lowest marketable tuber yield compared to all evaluated varieties. The low productivity of the local variety is ascribed to its susceptibility to late blight. On the other hand, Zengena was the tallest variety and ranked first in marketable tuber yield, but it was not significantly different from CIP384321.3 and Guasa in marketable tuber yield.

Therefore, Zengena, CIP384321.3 and Guasa appeared to be promising varieties

for the rainfed potato production system at Adet.

.

Table 1. Mean tuber yield and other agronomic characters of nine potato varieties under irrigated and rainfed potato production systems at Adet, northwestern Ethiopia, in 2001 and 2002.

Variety	Main stems per plant	Plant height (cm)	Tubers harvested per plot	Marketable tuber yield (t/ha)	Unmarketable tuber yield (t/ha)	Total tuber yield (t/ha)
			Irrigated			
Tolcha	3.9c	30.6d	97.0bc	9.66def	5.99abc	15.65cd
Awash	3.7c	35.3cd	141.3ab	12.90cde	7.50ab	19.50bcd
Genet	4.0bc	34.4cd	163.3a	14.56c	7.52ab	22.12abc
Guasa	5.8a	42.4bc	181.3a	16.02bc	8.90a	24.93ab
Local	4.6abc	34.2cd	153.8a	13.62cd	2.53c	16.15cd
Wochecha	4.2bc	32.0d	78.2c	6.72f	5.97abc	12.69d
Menagesha	4.9abc	46.7b	74.0c	8.25ef	5.72abc	13.97d
CIP384321.3	5.6ab	51.5ab	179.7a	22.19a	5.54abc	27.73a
Zengena	6.1a	59.6a	193.7a	19.65ab	4.19bc	23.85ab
Mean	4.8	40.7	140.3	13.63	5.99	19.62
CV (%)	19.9	14.5	22.2	19.5	47.2	22.4
			Rainfed			
Tolcha	4.8	45.8def	160.0abc	20.90bcd	4.95b	25.85cd
Awash	4.7	42.7ef	130.8c	14.25d	2.95bc	17.20e
Genet	5.2	53.3cd	207.3a	24.62b	2.66bc	27.27cd
Guasa	4.7	56.2bcd	183.0ab	26.88ab	5.57b	32.44bc
Local	5.0	38.2f	111.5c	1.44e	0.55c	1.99f
Wochecha	4.8	51.5cde	153.0bc	21.80bcd	2.39bc	24.19d
Menagesha	3.9	57.3bc	112.0c	17.19cd	3.55bc	20.73de
CIP384321.3	3.3	65.3ab	182.0ab	27.68ab	13.31a	40.99a
Zengena	4.2	74.8a	201.2ab	33.10a	2.11bc	35.20ab
Mean	4.5	53.9	160.1	20.87	4.23	25.09
CV (%)	23.2	12.4	19.5	21.6	65.4	16.1

*Means followed by the same letter (s) within a column are not statistically different; each value in the table is mean of 6 observations; * and ** stand for significance at $p \leq 0.05$ and $p \leq 0.01$, respectively; NS stands for not significant at $p \leq 0.05$*

According to across systems and years average performance, varieties were significantly different in plant height, number of tubers harvested per plot, marketable tuber yield, unmarketable tuber yield and total tuber yield (Table 2). Zengena and the local variety gave the highest and lowest marketable tuber yield, respectively. In addition, results of combined analysis of variance showed that

marketable tuber yield was significantly different between production systems (Table 2). The rainfed potato production system gave the highest average marketable tuber yield than the irrigated system (Table 2). This could be due to the prevailing average monthly maximum temperature, which was higher in irrigated potato production system than in the rainfed potato production system (Fig. 1). In agreement to this result, Mondal and Chatterjee (1993) reported lower potato tuber yield in warm condition than in cool condition. In addition, tuber initiation delays at higher than lower temperature (Mondal and Chatterjee, 1993). Moreover, higher temperature reduces tuber growth rate (Thornton et al., 1996). The average monthly minimum temperature was also lower in the irrigated than in the rainfed potato production system (Fig. 1). Low temperature retards vegetative growth and subsequently the productivity of the crop. Therefore, low productivity of potato in irrigated potato production system could also be attributed to the prevailing very low minimum temperature. Combined analysis of variance showed that variety × production system, variety × year and variety × system × year interaction effects were statistically significant (Table 3). That was an indication for different varietal response to the changes in growing conditions or environments.

Table 2. Across years and systems mean agronomic and tuber yield performance of nine potato varieties at Adet (2001 & 2002)

Variety	Main stems per plant	Plant height (cm)	Tubers harvested per plot	Marketable tuber yield (t/ha)	Unmarketable tuber yield (t/ha)	Total tuber yield (t/ha)
Tolcha	4.4	38.2ef	128.5b	15.28d	5.47bc	20.75de
Awash	4.2	39.0ef	136.1b	13.13d	5.23bc	18.35e
Genet	4.6	43.9de	185.3a	19.59c	5.11bc	24.69cd
Guasa	5.3	49.3cd	182.2a	21.45bc	7.23ab	28.68bc
Local	4.8	36.2f	132.7b	7.53e	1.54d	9.07f
Wochecha	4.5	41.7ef	115.6bc	14.26d	4.18cd	18.44e
Menagesha	4.4	52.0bc	93.0c	12.72d	4.63bc	17.35e
CIP384321.3	4.5	58.4b	180.8a	24.93ab	9.43a	34.36a
Zengena	5.1	67.2a	197.4a	26.38a	3.15cd	29.53b
Mean	4.6	47.3	150.2	17.25	5.11	22.36
CV (%)	21.5	13.3	20.8	21.4	54.7	18.8

Means followed by the same letter(s) within a column are not statistically different
*Each value in the table is mean of 12 observations; * and ** stand for significance at $p \leq 0.05$ and $p \leq 0.01$, respectively; NS stands for non-significant at $p \leq 0.05$*

Therefore, stability analysis was performed to identify a relatively stable variety among evaluated genotypes.A variety is said to be stable and adaptive if it has high mean yield, about unity regression coefficient and minimum deviation from regression (S^2di). Accordingly, the local variety was the most unstable variety. Zengena, CIP384321.3, Genet, Wochecha, Guasa, Tolcha and Menagesha had

regression coefficients higher than unity indicating that these varieties prefer favorable condition (Table 4). The local variety and Awash had regression coefficients less than unity indicating their response to the unfavorable condition. Therefore, there is no stable variety among evaluated genotypes to recommend for production in both systems. Similarly, Abalo *et al*. (2003) reported instability in marketable tuber yield among potato genotypes grown at different localities of Uganda. Hence, independent variety selection program is suggested for each potato production system.

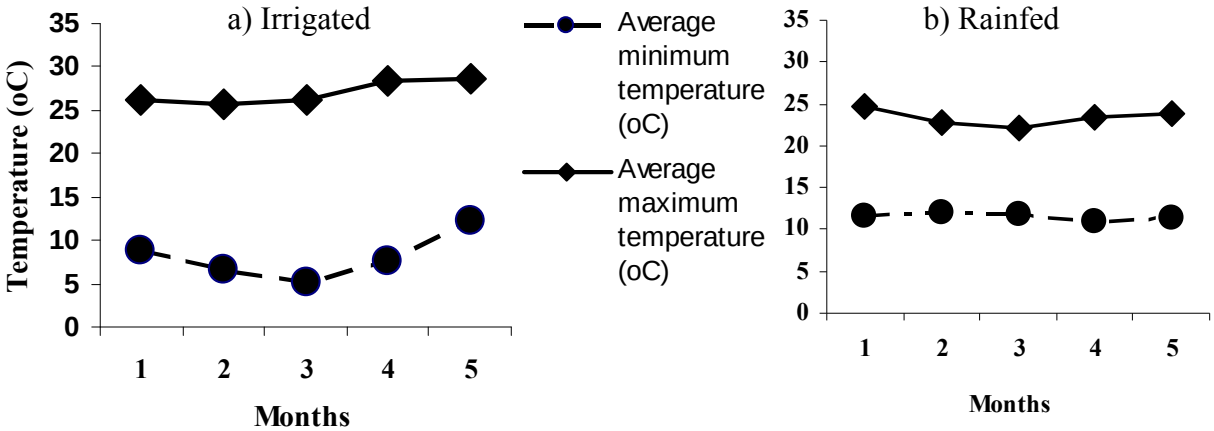

Fig. 1. Average monthly minimum and maximum temperatures during the a) irrigated and b) rainfed potato production systems at Adet.

Table 3. Combined Analysis of variance (ANOVA) on stem number, plant height, days to maturity, number of tubers harvested, marketable, total and unmarketable tuber yields

Source of variation	No. of main stems/ plant	Plant height (cm)	Days to maturity	No. of tubers/ plot	Marketable tuber yield (t/ha)	Un-marketable tuber yield (t/ha)	Total tuber yield (t/ha)
Year (Y)	**	**	**	NS	*	**	*
Systems (s)	*	**	**	**	**	**	**
Y x S	NS	**	**	**	**	**	NS
Variety (V)	NS	**	**	**	**	**	**
Y x V	NS	**	**	**	**	**	NS
S x V	*	**	**	**	**	**	**
YSV	**	**	**	**	**	**	NS

** and ** stand for significance at p≤0.05 and p≤0.01, respectively; NS stands for not significant at p≤0.05*

Table 4. Stability parameters for nine potato varieties in two years and production seasons (rainfed and irrigated) at Adet, northwestern Ethiopia, in 2001 and 2002.

Variety	Regression coefficient (bi)	Deviation from regression (S^2di)	Coefficient of determination	Mean marketable tuber yield (t/ha)
Tolcha	1.09	0.41	0.78	15.28
Awash	0.89	0.63	0.49	13.13
Genet	1.20	0.17	0.96	19.59
Guasa	1.12	0.57	0.66	21.45
Local	-0.64	1.07	0.15	7.53
Wochecha	1.19	0.87	0.49	14.26
Menagesha	1.09	0.18	0.95	12.72
CIP384321.3	1.37	0.61	0.72	24.93
Zengena	1.69*	0.15	0.98	26.37

* stands for significant difference from unity at 5% probability

Knowledge of correlations among different characters is vital to design an effective breeding program. Most economically important traits such as tuber yield are quantitatively inherited. The phenotypic expression of such traits is highly influenced by genotype × environment interaction effect. Consequently, it is very difficult and time consuming trying to improve tuber yield through direct selection. Hence, it is very important to estimate the degree of association of various highly heritable and easily measurable agronomic characters with yield. Simple linear correlation analysis was performed to assess the association of different characters under irrigated and rainfed potato production systems.

In the irrigated potato production system, marketable tuber yield showed positive and statistically significant association with number of main stems per plant, plant height and number of tubers harvested per plot (Table 5). De la Morena *et al.* (1994) also indicated that variation in tuber yield among cultivars was associated with the density of stems. In support of this observation, Baye Berihun *et al*. (2005) reported a considerably high positive correlation between tuber yield per plant and leaf area per plant at genotypic level. Therefore, these traits can be employed as indirect selection index for higher marketable tuber yield. Marketable tuber yield had positive and statistically significant association with plant height and number of tubers harvested per plot in rainfed potato production system (Table 5). This result revealed the importance of sink source ratio in both production systems. In the irrigated potato production system frost retards vegetative growth consequently tuber yield showed strong and positive association with number of main stems. On the other hand, in the rainfed potato production system the prevailing environment favors proliferation of main stem, subsequently showed negative correlation with marketable tuber yield. However, plant height and number of tubers harvested per plot showed positive correlation coefficient with marketable tuber yield in both systems and can serve as indirect selection index for higher marketable tuber yield in both production systems.

4. Conclusion

Varieties gave lower yield in the irrigated system than in the rainfed, suggesting variable responses in different systems. Therefore, it is suggested to commence independent variety development program for each system. Plant height and number of tubers harvested per plot showed positive and statistically significant association with marketable tuber yield, which could be used as indirect selection index for high marketable tuber yield.

5. Acknowledgements

Authors are indebted to horticulture research division of Adet Agricultural Research Center technical assistants. We are also grateful to the financial support of the Amhara Region Agricultural Research Institute, Bahir Dar, Ethiopia.

Table 5. Simple linear correlation coefficients among different traits of potato under different potato production systems, across systems and years at Adet

Traits	Plant height	Tubers harvested per plot	Marketable tuber yield	Unmarketable tuber yield	Total tuber yield
		Rainfed			
Main stems per plant	-0.64	-0.03	-0.37	-0.73*	-0.54
Plant height		0.64	0.85**	0.39	0.82**
Tubers harvested per plot			0.85**	0.31	0.79**
Marketable tuber yield				0.43	0.96**
Unmarketable tuber yield					0.68*
		Irrigated			
Main stems per plant	0.87**	0.58	0.69*	-0.09	0.61
Plant height		0.50	0.68*	-0.13	0.59
Tubers harvested per plot			0.92**	0.07	0.90**
Marketable tuber yield				-0.05	0.94**
Unmarketable tuber yield					0.31
		Across years and seasons			
Main stems per plant	0.43	0.61	0.45	-0.09	0.34
Plant height		0.54	0.82**	0.27	0.74*
Tubers harvested per plot			0.83**	0.33	0.76*
Marketable tuber yield				0.56	0.97**
Unmarketable tuber yield					0.74*

** and ** stand for significant at $p \leq 0.05$ and $p \leq 0.01$, respectively*

6. References

Abalo G, Hakiza JJ, El Bedewy R and Adipala E (2003). Genotype × environment interaction studies on yields of selected potato genotypes in Uganda. *African Crop Science Journal. 11 (1): 9-15.*

Baye Berihun, Ravishankar R and Harijt S (2005). Variability and associations among tuber yield and related traits in potato. *Ethiopian Journal of Agricultural Sciences. 18:103-121.*

Bhagsari AS, Webb RE, Phatak SC and Jororski CA (1988). Canopy photosynthesis, stomatal conductance and yield of Solanum tuberosum grown in warm climate. *American Potato Journal. 65: 393-406.*

CSA (2003). Ethiopian Agricultural Sample Enumeration, 2001/2002. *Statistical report on socio economic characteristics of the population in agricultural households, land use, area and production of crops, Part I.* Addis Ababa, Ethiopia.

De La Morena I, Guillen A and Garcia Del Moral LF (1994). Yield development in potatoes as influenced by cultivar and the timing and level of Nitrogen fertilization. *American Potato Journal. 71: 165-173.*

Eberhart SA and Russel WA (1966). Stability parameters for comparing varieties. *Crop Science. 6: 36-40.*

Elobu P and Osiru DSO (1994). Performance of three potato (*Solanum tuberosum* L.) genotypes in relation to plant population and applied nitrogen in a lowland area of Uganda. *In the proceedings of the 5th Triennial Symposium of the International Society for Tropical Root Crops, Kampala, Uganda 22-28 Nov. 1992. pp 181-184.*

Horton D (1987). *Potatoes: production, Marketing and Programs for Developing Countries. West view press, Colorado. pp 243.*

Lynch DR and Kozub GC (1991). The association between potato tuber yield and the components of yield in irrigated and dry land environments in the Prairies. *Canadian Journal of Plant Sciences. 71: 279-287.*

Mondal SS and Chatterjee BN (1993). Potao. In: Bose TK, Som MG, Kabir J (eds). Vegetable crops. Naya Prokash, Calcutta, India. pp. 382 - 469.

Singh RK and Chaudhary BD (1977). Biometrical methods in quantitative genetic analysis: Stability models. Kalyani Publishers, Ludhiana, India. pp. 239 – 266.

Tesfaye Abebe and Yigzaw Dessalegn (2008). Review of crop improvement research achievements and future focus in parts of Western Amhara Region: the case of Adet. *In: Tesfaye Abebe (ed.) proceedings of the 1st Amhara Region Regional Workshop on potato research and development achievements and transfer experiences and future directions Bahir Dar, Ethiopia, 20-21 Dec. 2007. pp 85-101.*

Thornton MK, Malik NJ and Dwellee RB (1996). Relationship between leaf gas exchange characteristics and productivity of potato clones grown at different temperatures. *American Potato Journal.* 73 (2): 63-77.

Eth.J.Sci & Technol. 5(2): 100-112, 2008 ISSN 1816-3378

Review

Biologically Active Compounds of Plant Foods: Prospective Impact on Human Health and Dilemmas Associated with these Compounds

Shimelis Admassu
Food Engineering Graduate Program, Chemical Engineering Department, Addis Ababa Institute of Technology.
E-mail: shimelisemire@yahoo.com, P.O.BOx 33381, Addis Ababa

Abstract
Several plant foods grown in Ethiopia contain significant amounts of biologically active compounds, which have both detrimental and beneficial effects on health. Such compounds as phytic acid, phytohaemagglutinins, tannins, saponins, enzyme inhibitors and α-galactosides provide health benefits. Benefits include reduced risks of heart and renal diseases, lower glycemic index for persons with diabetes, reduced risks of cancer and increased bifidobacteria population in the colon. On the other hand, other biologically active compounds impair health by destroying nutrients or reducing the uptake of essential elements through different mechanisms and giving astringent taste, odor, flavor, which can cause adverse physiological responses. Harmful compounds interfere with normal growth, reproduction, or health and reduce protein and carbohydrate utilization. The health benefits of selected substances from Ethiopian food crops need to be studied. Active compounds need to be isolated, identified and produced to explore their potential benefits with emphasis to develop new products and technologies. This paper is a review of available information on biologically active compounds of plant foods. Their adverse effects on health, their benefits and their potential to combat common nutrition-related ailments such as cancer and cardiovascular diseases are discussed.

Key words: Adverse effect; ecologically active compounds; plant foods; human health

1. Introduction
The majority of the world's population depends on plants for food. In the new millennium, researchers in Africa need to investigate, in a more holistic approach, the relationship between food and health. The idea of diet and health is, of course, not new and dates back to Hippocrates (400 BC), who coined the phrase 'Let food is thy medicine and medicine is thy food'. In the industrialized world, several factors, including the aging population, ever-increasing health-care costs, consumer demand for healthier foods, and food regulation, have been significant driving forces in moving functional foods into the corporate mainstream (Grusak, 2002). Current recommendations suggest that the intake of grains, fruits, and vegetables be increased for better health and management of chronic diseases such as cardiovascular diseases, diabetes and cancer (Lila and Raskin, 2005). However, there are concerns that the high intake of these foods may also increase the intake of bioactive compounds present in these foods (Morgan and Fenwick, 1990). The health beneficial effects of grains, fruits, and vegetables have been attributed in part to some of their naturally occurring bioactive compounds (Adlercreutz *et al.*, 1991; Messina and Barnes, 1991; Caragay, 1992). Bioactive compounds are chemicals that naturally occur in plants and plant-derived foods. They include a group of nutritive components found in herbs, fruits, vegetables, grains, legumes, nuts and spices. Many bioactive compounds function as crucial components in the natural defense system of their host plants, defending against infections and microbial invasion. Others give plants their flavors, aromas and pigments. Bioactive compounds are any food ingredients that may provide a health benefit which prevent or delay the onset or continuation of chronic deceases in humans and animals

beyond the nutrients they contain (Guhr and LaChance, 1997; Hasler, 1998; Shimelis, 2005).

Some of these beneficial chemicals block various hormonal actions and metabolic pathways that are associated with the development of cardiovascular disease and cancer, and other chemicals stimulate protective enzymes. The plant food chemicals appear to work alone and in combination, and perhaps in conjunction with vitamins and other nutrients in food, to prevent, halt or lessen disease (Duke, 1992). .In addition, they can reduce the risk of developing diabetes and help lower blood cholesterol levels, which can reduce in turns the risk of heart disease. All of the above claims are due to plant-derived "super nutrients," called biologically active compounds, which help to blur the line between food and medicine (Slavin, 2004; Shimelis, 2005).

The diet and health benefits of plant food crops as a basis for improving their nutritional quality need to be systematically evaluated through modern plant breeding and food processing technologies. Currently, research on exploring the potential of bioactive compounds is active in developed countries. Researchers constantly strive for and decipher the many ways of using biologically active compounds in foods and drugs, which might be used as front-line defense against many life-threatening diseases. As scientists continue to identify individual constituents in plants, they also discover more human health benefits. Some of the biologically active compounds are available on market such as flavanols soy capsule for relief of menopausal symptoms.

Biologically active compounds from plant foods for instance, raffinose family sugars (verbascose, stachyose and raffinose), phytohemagglutinins, phytic acid, phenolic compounds, saponins, trypsin inhibitors, phytoestrogens and lignanas attract considerable interest as a result of their diverse properties, both deleterious and beneficial (Ali and Muzquiz, 1998). The adverse effects of these bioactive compounds have always been associated with a number of substances which inhibit specific physiological function of humans and animals including digestion, enzyme activity, metabolism and absorption of nutrients. Active compounds from plant foods negatively affect the nutritive value of plant foods through direct and indirect reactions. Phytochemicals inhibit protein and carbohydrate digestibility; interfering with mineral bioavailability, induce pathological changes in intestine and liver tissue thus affecting metabolism, inhibit a number of enzymes and they bind nutrients making them unavailable (Bressani, 1993; Shimelis and Rakshit, 2007). A number of biological active compounds are under study for their potential health benefits in different countries. Different food processing methods are used for the reduction/removal of these bioactive compounds for consumption and threshold levels at which undesirable components may exert adverse effects must be established.

Grains, oilseeds, and specialty crops are widely grown in Ethiopia. Most of these commodities have the potential to be processed into functional foods/nutraceuticals for domestic and global markets. Along with enhancing the nutritive value and functional properties of common crops, there has been a trend towards value-added processing and extraction of the most nutritionally valuable constituents of biologically active compounds. Current research indicates that phytochemicals are have great potentials to

be used in foods and drugs aimed at front-line defense against many life threatening diseases. However, research and development on bioactive compounds is at its infancy because very little is known about their health benefits. This resulted in minimal use of these products. The objective of this paper was to describe diverse benefits and dilemmas associated with biologically active compounds from plant foods.

2. Potential Health Benefits of Biologically Active Compounds

Biologically active compounds have health benefits which, interestingly, appear to be similar to those suggested for the dietary fibers in fruits, vegetables and other crops (Table 2). Recent research on biologically active compounds is underway including application of biologically active compounds as nutraceuticals, functional foods, cosmetics and food processing industries (Grusak, 2002). Additionally, studies are under investigation to indicate the main groups of bioactive compounds giving a description of their localization, chemical properties and biological actions.

2.1 Oligosaccharides

Oligosaccharides are one of the most popular functional food components in South East Asia and exported to several countries including USA. The consumer products containing oligosaccharides included soft drinks, cookies, cereals and candies. Physiologically functional oligosaccharides meet two specific requirements: (a) they are not digestible by human digestive juices and (b) they are preferentially consumed by beneficial intestinal bacteria, bifidobacteria, in the colon.

Ingestion of oligosaccharides increases the bifidobacteria population in the colon, which in turn contributes to human health in many ways. The benefits of oligosaccharides ingestion arise from increased population of indigenous bifidobacteria in the colon which by their antagonistic effect, suppress the activity of putrefactive bacteria and reduce the formation of toxic fermentation products. The toxic metabolites formed during fermentation of foods in the colon include ammonia (liver toxin), amines (liver toxin), nitrosoamines (carcinogens), phenols and cresols (cancer promoters), indole and skatole (carcinogens), estrogens (suspected carcinogens or breast cancer promoters), secondary bile acids (carcinogens or active colon cancer promoters), aglycones (often mutagenic), and others (Hylemon and Glass, 1983; Hespell and Jeffrey-Smith, 1983; Kanbe, 1988; Mitsuoka, 1990, Hideo, 1994).

Health benefits of ingesting oligosaccharides are multifaceted. They proliferate bifidobactria and reduce detrimental bacteria (Wada *et al*., 1991), reduce toxic metabolites and detrimental enzymes (Saito *et al*., 1992), prevent pathogenic and autogenous diarrhea (Kurmann and Rasic, 1991), prevent constipation (Matsunami *et al*., 1992), protect liver function (Takasoye *et al*., 1990), reduce blood pressure (Masai *et al*., 1987), prevent cancer (Hirota, 1990) and produce nutrients (Hughes and Hoover, 1991). Reduction of toxic metabolites and detrimental enzymes by ingesting oligosaccharides has been shown in human tests and *in-vitro* human-feces culture tests (Kato *et al*., 1992; Saito *et al*., 1992). Ingesting oligosaccharides, which promotes bifidobacteria, reduces toxic metabolites, which in turn improves the detoxifying load of the liver (Takasoye *et al*., 1990).

2.2 Phytic acid

Phytic acid has gained significance as a naturally occurring antioxidant (Empson *et al*., 1991). The potential beneficial effects of phytic acid, such as delayed postprandial glucose absorption (Yoon *et al*., 1983), reduced plasma cholesterol and triglycerides (Katayama, 1995), reduced proliferation in different cell lines, including erythroleukaemia human mammary cancer cells (Shamsuddin, 1995) and its anti-cancer function have recently been discussed in the literature. *In vitro* studies of both human and rodents' cancer cell lines in research laboratory demonstrate that phytic acid reduces cell proliferation rate in all of the cell lines tested (Shamsuddin, 2002).

It is suggested that phytic acid prevents dental caries and platelet aggregation, plays a role in the treatment of hypercalciuria and kidney stones, and serves as antidote against acute lead poisoning, primarily due to its mineral-binding ability (Graf and Eaton, 1990). Phytic acid is found mostly in legumes and appears to possess anti-carcionogenic properties. This may be due to a number of factors including the recognized 'binding' properties of phytate. For this to occur successfully it is important that the integrity of phytic acid is preserved in the colon, which is a profuse microbial ecosystem via metabolization of colonic bacteria. According to most recent studies of phytic acid as a major component of cereal grains and beans is considered an important antioxidant and is increasingly used in various therapeutic diets for its protective effect on cancer of the colon and rectum (Steer and Gibson, 2002).

2.3 Saponins

The saponin content of foods is of interest because dietary saponins have been shown to lower plasma cholesterol concentrations in several species of animals (Oakenfull *et al*., 1979) and may be important in human diets to reduce the risk of heart disease (Potter *et al.,* 1980). Saponins have antioxidant properties and are used for health care treatments (Duhan *et al.,* 2001). Recent experimental investigations suggest that saponins reduce cholesterol and serve as anticancer and stimulate the immune system. Anticancer properties of saponins appear to be because they have antioxidant properties and they modulate the immune system and regulate cell proliferation (Rao, 1996). Animals have reduced cholesterol levels when fed either soy protein, daidzein (a soy isoflavone) or soy germ (Hendrick, 1999).

2.4 Other Benefits of Biologically Active Compounds

Biologically active organosulfur compounds contain various forms of sulfur, which give them their characteristic pungent aroma. These compounds include glucosinolates, thiosulfonates, phenols and polyphenols. They are often accepted by Ethiopians because cooking intensifies their odor and strong taste. Paradoxically, cooking can also boost their protective powers. The organosulfur group includes the cruciferous vegetables, such as bok choy, broccoli, brussels sprouts, cabbage, kale and turnips, and the onion and mustard families (Duke, 1992; Awika and Rooney, 2004). Glucosinolates are found in cruciferous vegetables and the mustard family. Broccoli glucosinolates are thought to activate protective liver enzymes that detoxify potential carcinogens and facilitate estrogen conversion into estrogen conjugates that are eliminated from the body (Kall, 1997). Glucosinolates are converted into several biotransformation products in the human body, particularly indole-3-carbinol, thiosulfonates and isothiocyanates. Thiosulfonates are also most notably found in onions and garlic as

well as in chives, leeks and shallots. When the plants are cut or smashed, sulfur compounds release biotransformation products including allicin, ajoene, allylic sulfides, vinyl dithin and D-allyl mercaptocysteine. Some of these are considered antiatherosclerotic and anticancer agents. Others are antibacterial, antiviral and antifungal (Lash, 1999). Garlic and onions, like their cruciferous relatives, can also selectively alter liver detoxification enzyme systems to reduce toxic by-products (Brady, 1991). Finally, garlic powder has been shown in numerous studies to lower cholesterol, often by as much as 10 percent (Silagy and Neil, 1994).

Phenols and polyphenols are among organosulfur compounds which have large family members of phytonutrients. These include rosemary, culinary herbs, red, blue and purple pigments found in fruits, vegetables, tea and red wine. All have a long history of use as food preservatives. In humans, they act as antioxidants, antifungals, anti-infectives and antiseptics (King and Young 1999; Tabak, 1999). Polyphenols, have an even wider range of biological activities due to their polyphenol content. Specific examples include apples, blueberries, cranberries, eggplants, red currants, grapes, grape juice, purple bell peppers, raspberries, red wine, and green and black tea. Polyphenols found primarily in citrus fruits are collectively known as bioflavonoids. These include rutin, kaempferol, quercetin, hesperidin and narigenin. They are considered to have antihistaminic, anti-inflammatory, antioxidant, anticlotting, antitumor and vascular effects (Formica and Regelson, 1995). A distinct group of polyphenols known as the flavan-3-ols includes anthocyanidins, proanthocyanidins, catechins and tannins. These have been extensively studied for their antioxidant, anticancer, antitumor and cardioprotective effects (Sato, 1999).

Hundreds of studies alone have been done on green tea catechins to assess their cardiovascular effects (Tijburg, 1997). Red wine, grape juice, pine bark and grape seed extracts have been studied for their anticlotting, antioxidant, cardiovascular and anticancer effects (Renaud and De Lorgeril 1992). Biologically active compounds are currently available in medical stores including garlic powder and others as health foods produced by American and South East Asian countries. Health benefits of some biologically active compounds are presented in Table 1.

3. The Detrimental Effects of Biologically Active Compounds

3.1 α-Galactosides

α-galactosides are oligosaccharides of the raffinose family of sugars, which include raffinose, stachyose and verbascose.

They contribute to flatulence production in humans and mono-gastric animals because of lack of the necessary α-galactosidase enzyme which helps to break down raffinose-series oligosaccharides during consumption of plant foods (Onigbinde and Akinyele, 1983). The raffinose family sugars then pass into the large intestine where microbial fermentation converts them into CO_2, H_2 and CH_4 gases, the main components of flatus (Becker *et al.*, 1974; Rao and Belavady, 1978). A number of investigators have demonstrated that the oligosaccharides, raffinose and stachyose, are the principal causes of flatulence in human and animal studies (Rackis *et al.*, 1970; Calloway *et al.*, 1971; Reddy *et al.*, 1980).

Table 1. The best known biologically active compounds and their benefits and sources

Biologically active Compounds	Potential Health Benefits	Plant Food Source
Anthocyanidins	Reduce risk of heart disease	Grapes, raspberries, blueberries, cherries
Carotenoids	Encourage normal cell growth, reduce risk of cancer	Yellow-orange vegetables and fruits, red fruits, dark green leafy vegetables
Catechins	Reduce risk of cancer	Green tea
Chalcones	Reduce risk of cancer	Licorice
Coumarins	Reduce risk of cancer	Carrots, caraway, celery, parsley
Curcumins	Reduce risk of cancer	Turmeric, ginger
Diallyl sulfide, disulfides, trisulfides	Reduce risk of cancer, of heart disease, antimicrobial	Onions, garlic, chives, leeks
Dithiolthiones	Reduce risk of cancer	Cruciferous vegetables
Ellagic acid	Reduce risk of cancer	Grapes, strawberries, raspberries, nuts
Flavonoids	Reduce risk of heart disease and cancer	Most fruits and vegetables
Glucarates	Reduce risk of cancer	Citrus, grains, tomatoes, bell peppers
Indoles, isothiocyanates	Reduce risk of cancer	Broccoli, cabbage, cauliflower, radish
Isoflavones	Lower blood cholesterol, risk of cancer, heart disease and osteoporosis	Soy foods (soybeans, tofu, soy milk, soy protein powder)
Alpha-linolenic acid	Lower blood cholesterol, reduce hypertension, reduce risk of heart disease, reduce risk of cancer, reduce inflammation, improve immune system	Vegetable oils (canola or soybean), flax seed
Lignans	Lower cholesterol and risk of cancer	Soybeans, flax seed, sesame
Liminiods	Reduce risk of cancer	Citrus, ginger, liquorice
Phenolic acids	Reduce risk of cancer	Most fruits and vegetables, teas and herbals; nuts, whole grains
Phthalides, polyacetylenes	Reduce risk of cancer	Caraway, celery, cumin, dill, fennel, parsley
Phytates	Reduce risk of cancer	Grains, legumes
Phytosterols	Reduce risk of cancer	Nuts, seeds, legumes
Saponins	Reduce risk of cancer	Beans, herbs, licorice root
Terpenoids	Reduce risk of cancer	Cherries, citrus, herbs (basil, oregano, thyme, sage)

Source: Guhr and LaChance (1997); Broihier(1999)

The most common form is the trisaccharide raffinose, the tetrasaccharide stachyose and the pentasaccahride verbascose (Yasushi *et al*., 1993). The fact that plant seeds stimulate intestinal gas formation has been recognized for many years and is one of the main reasons why people limit their consumption of legumes. Consequently, the presence of these sugars in plant food seeds is one of the major constraints in their full utilization as human food (Shimelis and Rakshit, 2005).

3.2 Phytic Acid

Phytic acid is the major phosphorus storage compound in plant seeds and can account for up to 80% of seed total phosphorus. The remaining phosphorus is represented by soluble inorganic phosphate and cellular phosphorus. Most of the phytic acid in plant foods is located in the cotyledons and not in the seed coat (Reddy *et al*., 1982). Because of its high density of negatively charged phosphate groups, phytic acid forms very stable complexes with mineral ions rendering them unavailable for intestinal uptake. As the phytic acid content of the diet increases, the intestinal absorption of zinc, iron and calcium decreases (Lopez, 2002). Zinc is an essential trace element involved in the immune function, in the activation of many enzymes and in growth. However, zinc deficiency has been recognized in East and Great Lakes Region of Africa due to inadequate dietary supply, abnormal blood losses or high physiological requirements for growth, puberty, pregnancy and lactation. Phytic acid strongly binds zinc in the gastrointestinal tract and reduces its availability for absorption and re-absorption in physiological pH range than other minerals (Flanagan, 1984). The amount of phytic acid, the type and amount of protein and the total zinc content have a major impact on the amount of zinc absorbed from plant foods.

Phytic acid is therefore, thought to be responsible for reducing the mineral bioavailability (Erdman and Forbes, 1981). Generally, phytic acid reduces the bioavailability of minerals, and the solubility, functionality and digestibility of proteins and carbohydrates. Manufacturing processes (kneading, soaking, fermentation, baking, toasting, extrusion-cooking) of plant foods can increase mineral bioavailability.

3.3 Saponins

The better-known biological effects of saponins are their capacity to cause lysis of erythrocytes (Khalil and El-Adawy, 1994), and to make the intestinal mucosa permeable (Johnson *et al.*, 1986). Saponins impart undesirable bitter and astringent characteristics to plant foodstuffs. They are foam producing glycosides and are detected by their hemolytic activity and surface-active properties.

3.4 Tannins and Phytohaemagglutinins

Tannins occur widely in plant foods specifically in cereal and legume seeds (Haard and Chism, 1996). These compounds are concentrated in the bran fraction of grains (Salunkhe *et al*., 1990). Tannins inhibit several enzymes and are located mainly in the seed coat. Reduction in protein digestibility due to the presence of tannins has been observed by several investigators (Elias *et al*., 1979; Bressani *et al*., 1983).

Tannin-protein complexes can cause inactivation of digestive enzymes and reduce protein digestibility by the interaction of protein substrate with ionizable iron (Salunkhe *et al*., 1990). The presence of tannins in food can therefore lower feed efficiency, depress growth, decrease iron absorption, damage the mucosal lining of the gastrointestinal tract, alter excretion of cations, and increase excretion of proteins and essential amino acids (Reddy and Pierson 1994). Dehulling, cooking and fermentation reduce the tannin content of cereals and other foods.

The biochemical nature of how the food tannins bind to food proteins is difficult to discern, primarily due to the complexity of tannin chemistry as well as the number of tannin species present in food (Sathe and

Salunkhe, 1984). Elias *et al.* (1982) found that tannin concentration was high in colored seed coats and low in white-coated plant food seeds. Moreover, there is a correlation between tannin concentration in the seed coat and trypsin inhibitor activity. The hulls have much greater amounts of trypsin inhibitor than the cotyledon. Probably most of the trypsin inhibitor activity of the hulls is attributable to tannins. Tannins inhibit the activity of trypsin chymotrypsin, amylase and lipase. Tannin-protein complexes can cause inactivation of digestive enzymes and reduce protein digestibility by the interaction of protein substrate with ionizable iron. The presence of tannins in plant food can therefore lowers feed efficiency, depress growth, decrease iron absorption, damage the mucosal lining of the gastrointestinal tract, alter excretion of cations, and increase excretion of proteins and essential amino acids (Reddy and Pierson, 1994).

Phytohaemagglutinins are proteins or glycoprotein substances, usually of plant origin, that bind to sugar moieties in cell walls or membranes and thereby change the physiology of the membrane to cause agglutination, mitosis or other biochemical changes in the animal red blood cells (Liener, 1983; Gupta, 1987). In general phytohaemagglutinins classified in to animal, plant, bacterial, fungal and virus Phytohaemagglutinins are the main toxic components in some plant foods. The toxicity of phytohaemagglutinins is characterized by growth depression in experimental animals and diarrhea, nausea, bloating and vomiting in humans (Liener, 1982). Phytohaemagglutinins have been used by immunologists for years to trigger DNA synthesis in lymphocytes, and more recently, to activate latent human immunodeficiency virus type 1 (HIV-1, AIDS virus) from human peripheral lymphocytes. Besides inducing mitosis, lectins are known for their ability to agglutinate many mammalian red blood cell types, alter cell membrane transport systems, alter cell permeability to proteins, and generally interfere with cellular metabolism (FDA, 1997). Phytohaemagglutinins, the presumed toxic agent, is found in many species of plant foods. Adverse health effects of biologically active compounds in plant foods are presented in Table 2.

The biochemical nature of how the food tannins bind to food proteins is difficult to discern, primarily due to the complexity of tannin chemistry as well as the number of tannin species present in food (Sathe and Salunkhe, 1984). Elias *et al.* (1982) found that tannin concentration was high in colored seed coats and low in white-coated plant food seeds. Moreover, there is a correlation between tannin concentration in the seed coat and trypsin inhibitor activity. The hulls have much greater amounts of trypsin inhibitor than the cotyledon.
Probably most of the trypsin inhibitor activity of the hulls is attributable to tannins. Tannins inhibit the activity of trypsin chymotrypsin, amylase and lipase. Tannin-protein complexes can cause inactivation of digestive enzymes and reduce protein digestibility by the interaction of protein substrate with ionizable iron. The presence of tannins in plant food can therefore lowers feed efficiency, depress growth, decrease iron absorption, damage the mucosal lining of the gastrointestinal tract, alter excretion of cations, and increase excretion of proteins and essential amino acids (Reddy and Pierson, 1994).

Table 2. Summary on adverse health effects of biologically active compounds present in plant foods

Biologically active compounds	Adverse health effects
Phytohemagglutinins	Growth depression, fatal, agglutination of animal red blood cells
Protease inhibitors	Pancreatic hypertrophy, dietary loss of S-amino acids, reduced protein utilization
Amylase inhibitors	Amylase inhibition, may hinder carbohydrate utilization
Flatulent factors (Oligosaccharides)	Flatus resulting in discomfort, abdominal rumblings, cramps, pain and diarrhea
Phytate	Reduced mineral bio-availability, altered protein solubility, enzyme inhibition
Oxalates	Chelation of dietary divalent cations and reduced bio-availability
Polyphenols (tannins)	Reduction in protein digestibility and utilization, inhibition of several enzymes
Cyanogens	Cyanide poisoning, acts as progoitrogens
Goitrogens	Inhibition of iodine binding to thyroidglans
Saponins	Bitter taste, foaming, hemolysis
Allergens	Several allergic reactions
Lathyrogens	Neurotoxic, nervous paralysis of lower limbs, fatal
Vicine and convicine	Haemolytic anemia (Favisms)
Off-flavors	Loss of certain amino acids, reduced product acceptability to consumers
Pytoalexins	Haemolysis, uncouple oxidative phosporylation
Estrogens	Growth inhibition, interference in reproduction
Lysionoalanine	Nephrotoxicity, reduction in available lysine, kidney cell nucleus and cytoplasm enlargement
Amino acid racemization	Generation of D-amino acids, may act as synergist to lysinoalanine in expression of nephrocytomegaly
Toxic amino acids	Structural analogs of protein amino acids, act as antimetabolites, potent inhibitors of several enzyme systems
Anti-vitamins	Increased vitamin requirements, rachitogenic, liver necrosis, muscular dystrophy

Source: Deshpande et al. (2000)

Phytohaemagglutinins are proteins or glycoprotein substances, usually of plant origin, that bind to sugar moieties in cell walls or membranes and thereby change the physiology of the membrane to cause agglutination, mitosis or other biochemical changes in the animal red blood cells (Liener, 1983; Gupta, 1987). In general phytohaemagglutinins classified in to animal, plant, bacterial, fungal and virus Phytohaemagglutinins are the main toxic components in some plant foods. The toxicity of phytohaemagglutinins is characterized by growth depression in experimental animals and diarrhea, nausea, bloating and vomiting in humans (Liener, 1982). Phytohaemagglutinins have been used by immunologists for years to trigger DNA synthesis in lymphocytes, and more recently, to activate latent human immunodeficiency virus type 1 (HIV-1, AIDS virus) from human peripheral lymphocytes. Besides inducing mitosis, lectins are known for their ability to agglutinate many mammalian red blood cell types, alter cell membrane transport systems, alter cell permeability to proteins, and generally interfere with cellular metabolism (FDA, 1997).

Phytohaemagglutinins, the presumed toxic agent, is found in many species of plant foods. Adverse health effects of biologically active compounds in plant foods are presented in Table 2.

4. Conclusion

It is evident that both health benefits and adverse effects may be attributed to biologically active compounds in plant foods. In many cases, the same interactions that make them adverse effect also are responsible for their health benefits. Overall, the most effective solutions too many major human health conditions lie in the natural components of foods we eat, rather than expensive medical intervention. The challenge is to find and incorporate a balance of the functional ingredients in everyday foods at adequate levels.

Different plant food sources, which are currently underutilized, are worth considering as a source of health-promoting biologically active compounds. Products containing many of these active compounds are emerging in developed countries, based on results obtained from several completed and ongoing studies. The scientific community has produced a growing body of evidence indicating that naturally occurring biologically active compounds are still the beast health insurance. Therefore, different strategies should be put in place in Ethiopia such initiating research activities on phytochemicals, establishing linkage among professionals, documenting endogenous knowledge on the application of phytochemicals. Current investigations have demonstrated that both adverse and health and disease-fighting benefits perhaps are attributed to biologically active compounds in plant foods. Ultimately, the greatest promise of biologically active compounds might be their ability to spark a dramatic and widespread shift in the understanding and appreciation of plant foods. With a greater understanding of biochemistry and human physiology, biologically active compounds could well drive the food and supplement the industry and can be used as potential health bodyguards in the near future. Researchers caution that choosing foods containing naturally occurring biologically active phytochemicals is still the best health insurance in order to harvest better-educated public, wealthier and more willing to self-medicate with plant foods and supplements from plant resources.

Available data on biologically active compounds are too limited to draw reasonable conclusions in the Ethiopian context. Therefore, to explore their true properties and applications, critical research results are imperative before applying them widely. Although the matter has so far remained a challenge, biologically active compounds can easily be made available and used in the near future.

5. Acknowledgments

The author would like to express genuine gratefulness to the Ethiopian Institute of Agricultural Research and CIAT (Centro Internacional de Agricultura Tropical/ International Center for Tropical Agriculture) for granting financial support for this endeavor. Special recognition is due to Tesfamichael Alemseged and Alemtsehay Assefa for their precious support during the manuscript preparation.

5. References

Adlercreutz H, Mousavi Y, Loukpvaara M, and Hamalainen E (1991). Lignans, isoflavones, sex hormone metabolism and breast cancer. In *The New Biology of Steroid*

Hormones, ed. R. Hochberg & F. Naftolin. Raven Press, New York, USA, pp.145-154.

Ali R and Muzquiz M (1998). ANF's in tropical legume seeds for human nutrition, in *Recent advances of research in antinutritional factors in legume seeds and rapeseed*, ed. by Jansman, AJM, Hill, G.D, Huisman, J. van der Poel, AFB, Wageningen Pers, Wageningen.pp.107.

Awika MS and Rooney WL (2004). Sorghum phytochemicals and their potential impact on human health: a review. *Phytochem*. 65: 1199-1221.

Becker R Olson AC, Frederick DP, Kon PS, Gumbmann MR, and Wagner JR (1974). Conditions for the autolysis of alpha-galactosides and phytic acid in California small beans. *J. Food Sci.* 39:766-769.

Brady JF (1991). Inhibition of cytochrome P-450 2E1 by diallyl sulfide and its metabolites. *Chem Res Toxicol*. 4:642-647.

Bressani R (1993). Grain quality of common beans. *Food Rev. Int.* 9: 217-297.

Bressani R, Elias LG, Wolzak A, Hagerman A, and Butler LG (1983). Tannins in common beans: methods of analysis and effects on protein quality. *J. Food Sci.* 48:1000-1007.

Broihier K (1999). The phytochemical renaissance. *Food Proc*.44:46-48.

Calloway DH, Hickey CA, and Murphy EL (1971). Reduction of intestinal gas-forming properties of legumes by traditional and experimental food processing methods. *J. Food Sci*. **36**, 251.

Caragay AB (1992). Cancer protective foods and ingredients. *Food Technol*. 46: 65-68.

Deshpande SS, Salunkhe DK, Oyewole OB, Azam-Ali S, Battcock M, and Bressani R (2000). Fermented grain legumes, seeds and nuts. A global perspective. FAO Agricultural Series Bulletin, 142. pp. 1-17. Rome, Italy.

Duhan A, Khetarpaul N, and Bishnoi S (2001). Saponin content and trypsin inhibitor activity in processed and cooked pigeon pea cultivars. *Int. J. Food Sci. Nutr*. 52: 53-59.

Duke J (1992). Handbook of biologically active phytochemicals and their activities. Boca Raton (FL): CRC Press; pp 99-131.

Elias LG, DeFernandez DG, and Bressani R (1979). Possible effects of seed coat polyphenolics on the nutritional quality of bean products. *J. Food Sci.* 44: 524-529.

Elias LG, Bressani R, and Braham JE (1982). Reduction of digestibility of legume proteins by tannins. *Plant Foods Hum. Nutr.*4: 43-55.

Empson KL, Labuza TP, and Graf E (1991). Phytic aci as a food antioxidant. *J. Food Sci.* 56:560-563.

Erdman JWJ and Forbes RM (1981). Effects of soy protein on mineral availability. *J. Am. Oil Chem. Soc.* 58:489-495.

FDA (1997). U.S. Food and Drug Administration (FDA), center for food safety and applied nutrition. Food borne pathogenic microorganisms and natural toxins hand book. pp.347-417.

Flanagan PR (1984). A model to produce pure zinc deficiency in rats and its use to demonstrate that dietary phytate increases the excretion of endogenous zinc. *J. Nutr.* 114: 493-502.

Formica JV and Regelson W (1995). Review of the biology of quercetin and related bioflavonoids. *Food Chem. Toxicol*. 33:1061-80.

Graf E and Eaton JW (1990). Antioxidant functions of phytic acid. *Free Radical Biol. Med.*8:61-69.

Grusak AM (2002). Phytochemicals in plants: genomics-assisted plant improvement for nutritional and health benefits: a review. *Curr. Opin. Biotechnol.*13:508-511.

Guhr G and LaChance PA (1997). Role of phytochemicals in chronic disease prevention. Chapter 32, In Nutraceuticals: Designer foods III: Garlic, soy, licorice. Food nutrition Press, pp.311-364.

Gupta YP (1987). Antinutritional and toxic factors in food legumes: a review. *Plant Foods for Human Nutr.* 37:201-228.

Haard NF and Chism G (1996). Characteristics of edible plant tissues. Food Chemistry. New York, Marcel Dekker, Inc., pp.943-1011.

Hasler CM (1998). Functional foods: Their role in disease prevention and health promotion. *Food Technol.* 52: 63-70.

Hendrick S (1999). Are saponins and/or other soybean components responsible for hypocholesterolemic effects of soybean foods? Third international symposium on the role of soy in preventing and treating chronic disease. Washington, D.C.; 1999 October 31st -November 3rd.

Hespell RB and Jeffrey-Smith C (1983). Utilization of nitrogen sources by gastrointestinal tract bacteria. In " Hentges", pp.167-187.

Hideo T (1994). Health effects of oligosaccharides. *Food Technol*. 48: 61-65.

Hirota T (1990). The health maintenance effects of lactic acid bacteria being used in milk products. *New Food Ind.* 32:9-17.

Hughes JB and Hoover DG (1991). Bifidobacteria: Their potential for use in American dairy products. *Food Technol.* 45:74,76,78-80,83.

Hylemon PB and Glass TL (1983). Biotransformation of bile acids and cholesterol by the intestinal microflora. In "Hentges", pp.189-213.

Johnson IT, Gee JM, Price KR, Curl CL, and Fenwick GR (1986). Influence of saponins on gut permeability and active nutrient transport *in vitro*. *J. Nutr*. 116: 2270-2277.

Khalil AH and El-Adawy TA (1994). Isolation, identification and toxicity of saponins from different legumes. *Food Chem.* 50: 197-201.

Kall MA (1997). Effects of dietary broccoli on human drug metabolizing activity. *Cancer Letter*. 114:169-70.

Kanbe M (1988). Lactic acid bacteria as physiologically functional food. *New Food Ind.* 30:77-87.

Katayama T (1995). Effect of dietary sodium phytate on the hepatic and serum levels of lipids and on the hepatic activities of NADPH-generating enzymes in rats fed on sucrose. Biosci Biotechnol Biochem. 59:1159-1160.

Kato Y, Shirayanagi S, Mizutani J, and Hayakawa K (1992). The effects of soybean oligosaccharides on intestinal metabolic activity. Soya Oligo Japan Co. R & D Center, Tokyo.

King A Young G (1999). Characteristics and occurrence of phenolic phytochemicals. *J. Am. Diet Assoc.* 99:213-218.

Kurmann JA and Rasic JL (1991). The health potential of products containing bifidobacteria. In" Therapeutic properties of fermented milk", ed., R.K. Robinson, pp.117. Elsevier Applied Science Publishing Co., Inc., New York.

Lash LJ (1999). Garlic dietary supplements: an assessment of product information provided by garlic manufacturers. *Minnesota Pharmacist*. 53:13-14.

Liener IE (1982). Toxic constituents in legumes, in chemistry and biochemistry of legumes, ed by Arora Sk, Oxford and IBH, New Delhi. pp.217.

Liener IE (1983). Toxic constituents in legumes. In: *Chemistry and Biochemistry of Legumes.* Arora, S.K. (ed.), pp.217-257.Oxford and IBH, New Delhi.

Liener IE and Kakade ML (1980). Toxic constituents of plant food stuffs (2nd ed.). Academic Pres, New York.

Lila MA and Raskin I (2005). Health-related interactions of phytochemicals. R: Concise reviews/hypotheses in food science. *J. Food Sci.* 70: R20-R27.

Lopez W, Leenhardt T, Coudray C and Remesy C (2002). Minerals and phytic acid interactions : Is it a real problem for human nutrition ? *Int. J. Food Sci. Technol.* 37:727-739.

Masai T, Wada K, Hayakawa K, Yoshihara I, and Mitsuoka T (1987). Effects of soybean oligosaccharides on human intestinal flora and metabolic activities. *J. Bacteriol*. 42:313-317.

Matsunami T, Mochizuki N, and Masai T (1992). The effects of soybean oligosaccharides containing soft drink on defecation and gastrointestinal conditions. Soya Oligo Japan Co., R&D Center.

Messina M and Barnes S (1991). The role of soy products in reducing risk of cancer. *J. Nat. Cancer Inst.* 83: 541-546.

Mitsuoka T (1990). Bifidobacteria and their role in human health. *J. Ind. Microbiol. Biotechnol*. 6: 263-267.

Morgan M and Fenwick G (1990). Natural food borne toxicants. *Lancet.* 336:1492-1495.

Oakenfull DG, Fenwick DE, Hood RL, Topping DL and Illuman RJ (1979). Effects of saponins on bile acids and plasma lipids in the rat. *Br. J. Nutr*. 42:209-216.

Onigbinde AO and Akinyele IO (1983). Oligosaccharide content of 20 varieties of cowpeas in Nigeria. *J. Food Sci.* 48: 1250-1251, 1254.

Potter JD, Illuman RJ, Calvert GD, Oakenfull DG, and Topping DL (1980). Soya saponins, plasma lipids, lipoproteins and fecal bile acids: a double blind cross-over study. *Nutr. Report Int.* 22: 521-528.

Rackis JJ, Sessa DJ, Steggerda FR, Shimizu T, and Anderson J (1970). Soybean factors relating to gas production by intestinal bacteria. *J. Food Sci.*35: 634-637.

Rao AV (1996). Anticarcinogenic properties of plant saponins. Second international symposium on the role of soy in preventing and treating chronic disease. Brussels, Belgium. pp. 15-18.

Rao PU and Belavady B (1978). Oligosaccharides in pulses: Varietal differences and effects of cooking and germination. *J. Agric. Food. Chem*. 26:316-324.

Reddy NR, Salunkhe DK, and Sharma RP (1980). Flatulence in rats following ingestion of cooked and germinated black gram and a fermented product of black gram and rice blend. *J. Food Sci.* 45: 1161-1164.

Reddy NR, Sathe SK, and Salunkhe DK (1982): Phytate in legumes and cereals. *Adv. Food Res*. 28: 1-92.

Reddy NR and Pierson MD (1994). Reduction in antinutrtional and toxic components in

plant foods by fermentation. *Food Res. Int.* 27: 281-290.

Renaud W and De Lorgeril M (1992). Wine, alcohol, platelets, and the French paradox for coronary heart disease. *Lancet.* 339:1523-1526.

Saito Y, Takano T, and Rowland I (1992). Effects of soybean oligosaccharides on the human gut microflora in *in vitro* culture. *Micro. Eco.* 5: 105-111.

Salunkhe DK, Chavan JK, and Kadam SS (1990). Dietary tannins: Consequences and remedies, CRC Press, Inc. pp.34-39. Boca Raton, FL, USA.

Sathe SK and Salunkhe DK (1984). A review: Technology of removal of unwanted components of dry beans. *CRC Crit. Rev. Food Sci. Nutr.* 21:263-287.

Sato M (1999). Cardioprotective effects of grape seed proanthocyanidins against ischemic reperfusion injury. *J. Mo.l Cell Cardiol*.31:1289-1297.

Shamsuddin AM (1995). Inositol phosphates have novel anticancer function. *J. Nutr,* 125 :725S-732S.

Shamsuddin AM (2002). Anti-cancer function of phytic acid. *Int. J. Food Sci. Technol*. 37:769-782.

Shimelis Admassu (2005). Influence of processing on antinutrients, raffinose family oligosaccharides and *in vitro* protein digestibility of improved dry bean (*Phaseolus vulgaris* L.) varieties grown in Ethiopia. A Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Engineering. Asian Institute of Technology. Bangkok, Thailand.

Shimelis Admassu and Rakshit SK (2005). Antinutritional factors and *in vitro* protein digestibility of improved haricot bean (*Phaseolus vulgaris* L.) varieties grown in Ethiopia. *Int. J. Food Sci. Nutr.* 56:377-387.

Shimelis Admassu and Rakshit SK (2007). Effect of processing on antinutrients and *in vitro* protein digestibility of kidney bean (*Phaseolus vulgaris* L.) varieties grown in East Africa. *Food Chem.* 103: 161-172.

Silagy C and Neil A (1994). Garlic as a lipid lowering agent-a meta-analysis. *J. R. Coll. Phys*. 28:39-45.

Slavin J (2004). Whole grains and human nutrition. *Nut. Res. Rev.*17:117-128.

Steer E and Gibson R (2002). The microbiology of phytic acid metabolism by gut bacteria and relevance for bowel cancer. *Int. J. Food Sci. Technol.* 37:783-790.

Tabak M (1999). Cinnamon extracts' inhibitory effect on Helicobacter pylori. *J Ethnopharmacol.* 67:269-277.

Takasoye M, Inoue N, and Knuma C (1990). Clinical investigation of feces improvements by soybean oligosaccharides. Rinsho toh Kenkyu (Clinics and Research) 67:304-310. In Japanese.

Tijburg LB (1997). Tea flavonoids and cardiovascular diseases: a review. *Crit Rev Food Sci Nutr*. 37:771-785.

Wada K, Watabe J, Mizutani J, Suzuki H, Kiriu N, Hayakawa K, and Yamaguchi C (1991). Effects of soybean oligosaccharides intake on fecal microflora, enzyme activity, ammonia and frequency of evacuation in elderly persons. *Bifidus*.4:135-140.

Yasushi K, Takanobu S, and Robert O (1993). Soybean oligosaccharides. In: Oligosaccharides production, properties and applications. Ed. Teruo.N. Japanese technology reviews. Section E, Biotechnology. Gordon and Breach Science Publishers, SA. Japan. Volume 3, number 2, pp.175-203.

Yoon JH, Thompson LU, and Jenkins DJ (1983). The effect of phytic acid on *in vitro* rate of starch digestibility and blood glucose response. *Am. J. Clin. Nutr*. 38:835-842.

Eth.J.Sci & Technol. 5(2):114-123, 2008 ISSN 1816-3378

Spectral Psychoanalysis of Speech under Strain

Durga Prasad Sharma [1], Prathap M[2] and Solomon Tadesse[3]
[1]*Professor, AMIT, under UN Development Program dp.shiv08@gmail.com*
[2]*Department of Computer Science and Engineering, Faculty of Engineering, Bahir Dar University, Ethiopia.*
[3]*Arbaminch University, Ethiopia*

Abstract
The non-verbal content of speech carries information about the physiological and psychological condition of the speaker. Psychological strain is a pathological element of this condition, of which one of the causes is accepted to be Exam-Strain. Objective, quantifiable correlates of strain are searched for by means of measuring the acoustic modifications of the voice brought about by Exam-Strain. Different voice features from the speech signal to be influenced by strain are: loudness, fundamental frequency, jitter, zero-crossing rate, speech rate and high-energy frequency ratio. To examine the effect of Exam-Strain on speech production an experiment was designed. Final Year students of age group 22 to 24 were selected and assignment was given to them and instructs them that have viva on that assignment and their performance in the viva will decide their final internal marks in the examination. The experiment and the psychoanalysis of the test results are reported in this paper.

Keywords: Speech; Strain; Spectral Psychoanalysis; Quantifiable; Neural Network; pathological

1. Introduction
Feelings are the unique features in the creatures. Emotions have been long been recognized to be an important aspect of human beings. More recently, psychologists have begun to explore the function of emotions as a positive component in human cognition and intellect. Vocal language comes from our inside of feelings.

Feature such as emotions, mood, physical characteristics and further pragmatic information are contained in the speech signals. Many of these characteristics are also audible. An emotional speech with high content differs in some parameter from unbiased/neutral speech. In recent years, the interests for automatically detection and interpretation of emotions in speech have grown and vocal emotions have also tended to be studied in segregation. About 25-30% of information contents in clean speech signal refer to the speaker. These linguistically immaterial speaker characteristics make speech recognitions less effective but can be used for speaker recognitions and psychoanalysis of speaker's health state and emotional status.

With the increasing demand for voice based and speech technology systems, there is an increasing demand for processing of emotions and other pragmatic effects of human beings. In some cases, it is very important to detect the emotional state of person for an instance strain fatigue.

Standard speech may be regarded as speech made in a quiet room with no task obligations. Strain in speech, on the other hand, is a result of speech produced under emotional states, fatigue, environmental noise, heavy workload, and or sleep loss. Here some of the consequences of physiological strain are respiratory changes including increased respiration rate, irregular breathing and increased muscle tension of the vocal cords. These factors may result in irregular vocal fold movement and other vocal system modifications that ultimately affect the quality of the utterances. The presence of strain in speech causes changes in phoneme production with respect to glottal source factors, pitch, intensity, duration, and spectral shape. In linear acoustic theory,

speech production process is described in terms of source filter model. This model assumes plane wave propagation in the vocal tract and neglects nonlinear terms. Linear acoustic theory suggests that frequency in vocal tract filter; intensity and duration of glottal signal may be assumed to change due to strained speech production. In this paper, linear acoustic features and nonlinear features in frequency domain have been investigated in strain classification (Ververidis and Kotropoulos, 2006)

2. Speech Correlators of Strain

Features, which are usually applied for detecting the emotional strain, are:

Fundamental frequency: The fundamental tone, often referred to simply as the fundamental and abbreviated of, is the lowest frequency in a harmonic series. The fundamental frequency ($F0$) of a periodic signal is the inverse of its period, which may be defined as the smallest positive member of the infinite set of time shifts that leave the signal invariant. This definition applies strictly only to a perfectly periodic signal. The significance of defining the pitch period as the smallest repeating unit can be appreciated by nothing that two or more concatenated pitch periods from a repeating pattern in the signal. However, the concatenated signal unit obviously contains redundant information.

Formats: A format is a peak in the frequency spectrum of a sound caused by acoustic resonance. In phonetics, the word refers to sounds produced by the vocal tract. In acoustic, it refers to resonance in sound sources, notably musical instruments, as well as that of sound chambers. However, it is equally valid to talk about the format frequency of the air in a room, as exploited; Formats are the distinguishing or meaningful frequency components of human speech and of singing. By definition, the information that humans require to distinguish between vowels can be represented purely quantitatively by the frequency contents of the vowel sounds. Formats are the characteristics partials that identify vowels to the listener. Most of these formats are produced by the tube ad chamber resonance, but a few whistle tones derive form periodic collapse of venturi effects low-pressure zones. The format with the lowest frequency is called f1, the second f2, and the third f3. Most often the two first formants, f1 and f2, are enough to disambiguate the vowels. These two formats are primarily determined by the position of the tongue.

Duration: Duration is a property of a tone that becomes one of the bases rhythm. A tone may be sustained for varying lengths of time. For example, an event in the common sense has a duration greater than zero (but not very long), but in certain specialized senses (such as in the theory of relativity), a duration of zero. It is often cited as one of the fundamental aspects of music, see also rhythm. Durations, and their beginnings and endings, may be described as long, short, or taking a specific amount of time. Often duration is described according to terms borrowed from descriptions of pitch.

Zero Crossing: The zero-crossing rate is the rate of sign-changes along a signal, i.e., the rate at which the signal changes from positive to negative or back. This feature has been used heavily in both speech recognition and music information retrieval and is defined formally as:

$$zcr = \frac{1}{T}\sum_{t=0}^{T-1}\mathbb{I}\{s_t s_{t-1} < 0\}$$ Equation (1)

Where s is a signal of length T and the indicator function $\mathbb{I}\{A\}$ is 1 if its argument A is true and 0 otherwise.

Power Spectral Density: Sinusoidal representation has been widely applied to speech modification, low bit rate speech and audio coding. Usually, speech signal is analyzed and synthesized using the overlap-add algorithm or the peak-picking algorithm. But the overlap-add algorithm is well known for high computational complexity and the peak-picking algorithm cannot track the transient and syllabic variation well. Peaks are picked in the curve of power spectral density for speech signal; the frequencies corresponding to these peaks are arranged according to the descending orders of their corresponding power spectral densities. These frequencies are regarded as the candidate frequencies to determine the corresponding amplitudes and initial phases according to the least mean square error criterion (Levitt and Rabiner, 1971; Johnstone and Scherer, 1999).

3. Methodology

In this research work the samples have been taken of the persons those who are in the age of 22 to 24 year and collecting all the samples of the speaker at the time of their viva examination before and after the examination for psychoanalysis of strain in speech. All the samples collected used as a database for the spectrum psychoanalysis of the speech under strain. In order to check the whether the speech have strain or not. For this checking the Multilayer Back Propagation Algorithm & the Matlab Tool box is used. The block diagram of method used is shown below (Rule, 1969; Schafer and Rabiner, 1971).

Neuron Model (logsig, tansig, purelin)

An elementary neuron with *R* inputs is shown below. Each input is weighted with an appropriate *w*. The sum of the weighted inputs and the bias forms the input to the transfer function *f*. Neurons can use any differentiable transfer function *f* to generate there output

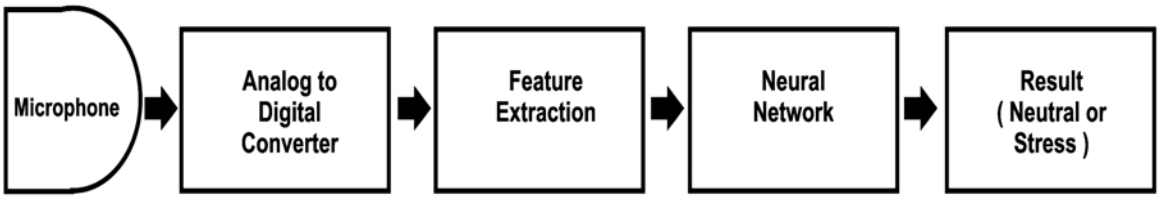

Fig .3.1. Block diagram of proposed method

.

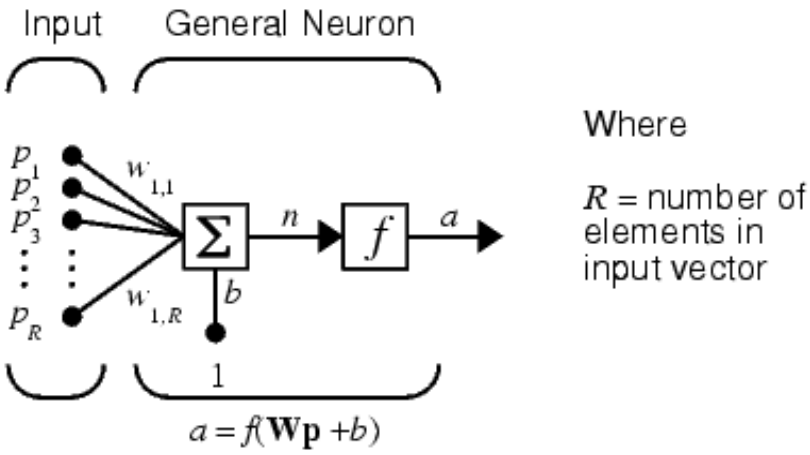

Fig.3.2. Multilayer networks often use the log-sigmoid transfer function `logsig`

4. Observations

The waveforms of features viz-fundamental frequency,

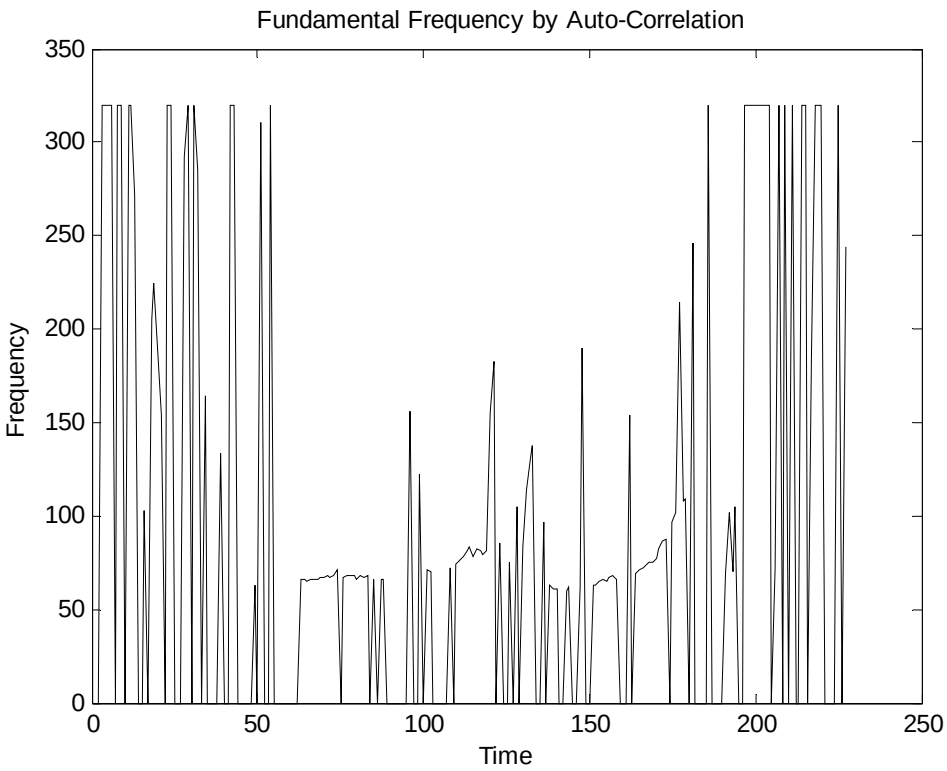

Fig. 4.1. Fundamental Frequency for Neutral Sample

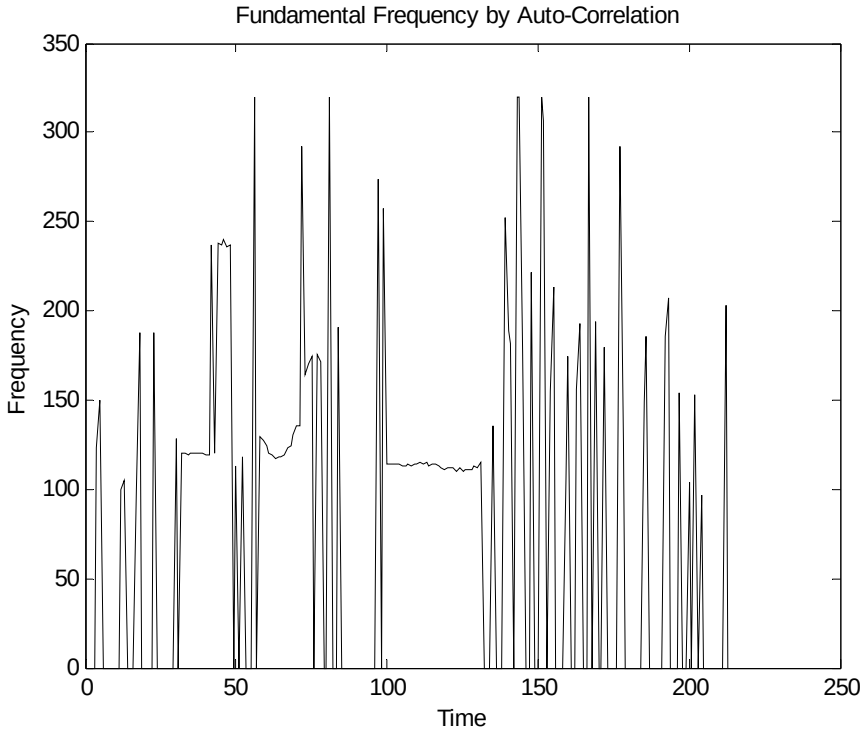

Fig.4.2. Fundamental Frequency for Strain Sample

The waveforms of features viz-Power Spectral Density

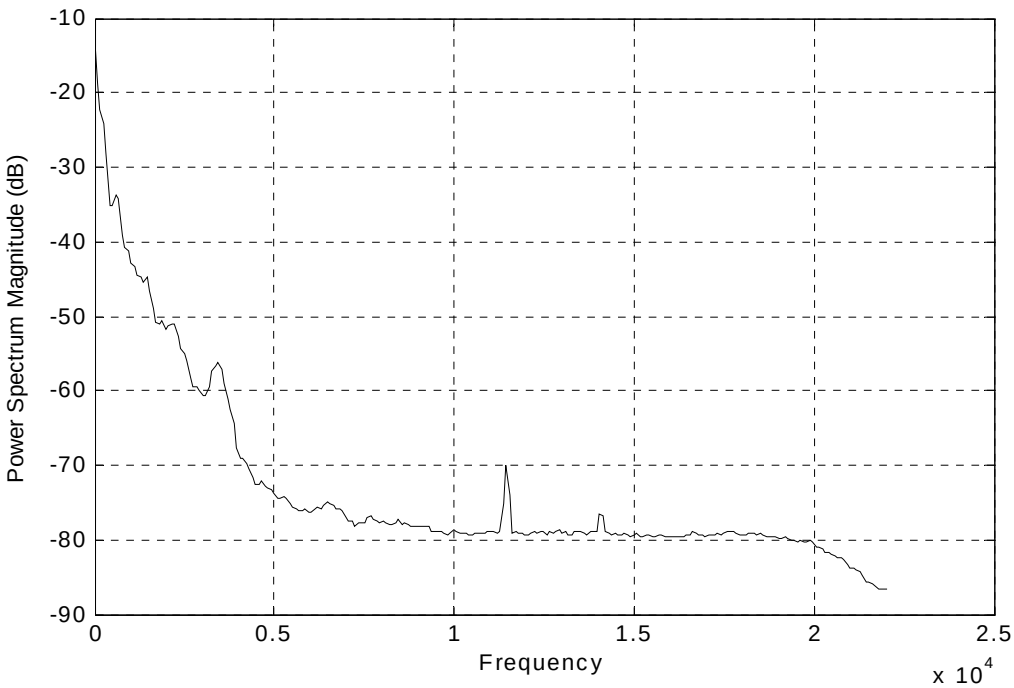

Fig. 4.3. Power Spectral Density for Neutral Sample

The waveforms of features viz-Short Time Average Energy

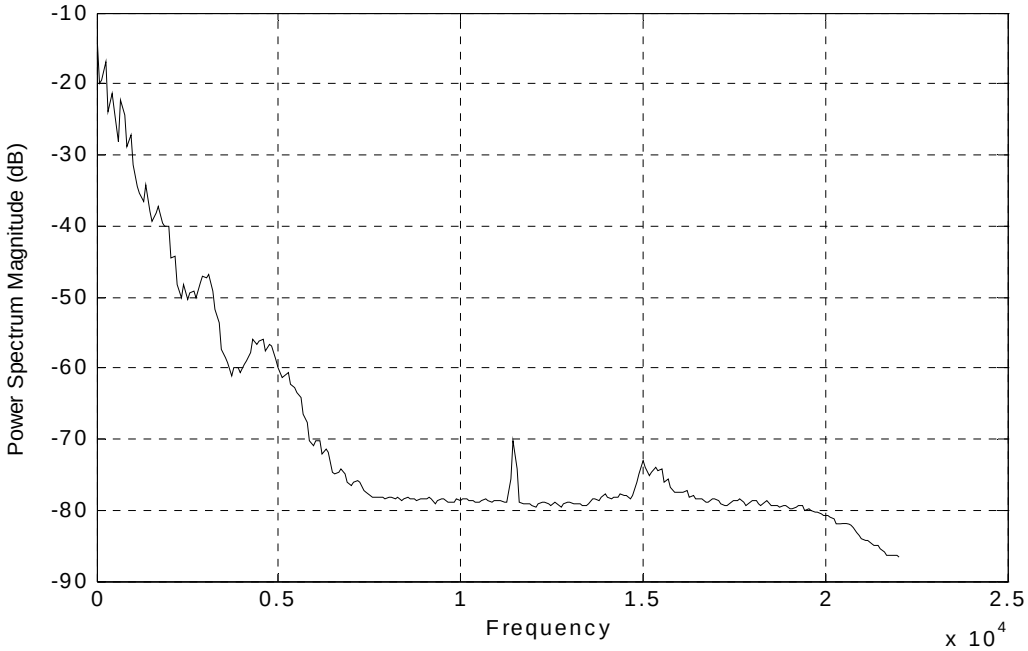

Fig. 4.4. Power Spectral Density for Strain Sample

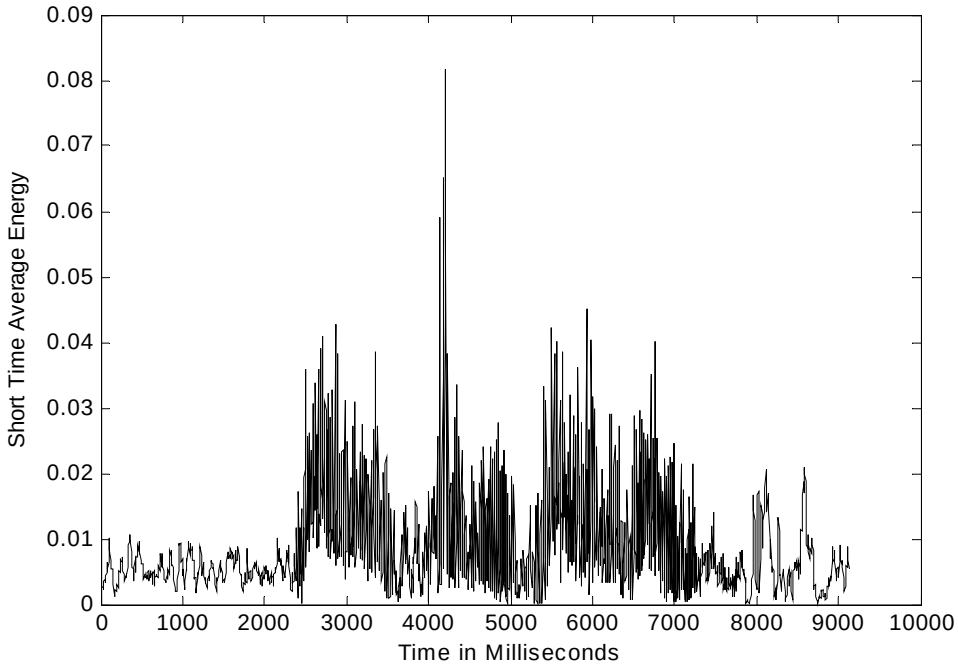

Fig 4.5. Short Time Average Energy for Neutral Sample

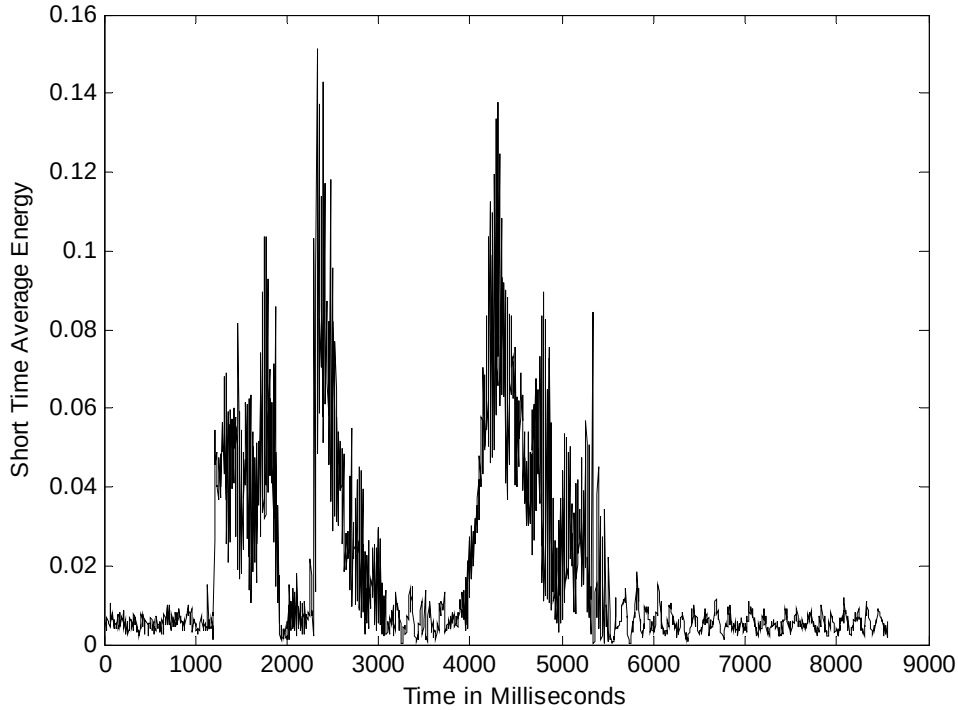

Fig.4.6. Short Time Average Energy for Strain Sample

The waveforms of features viz-Zero Crossing

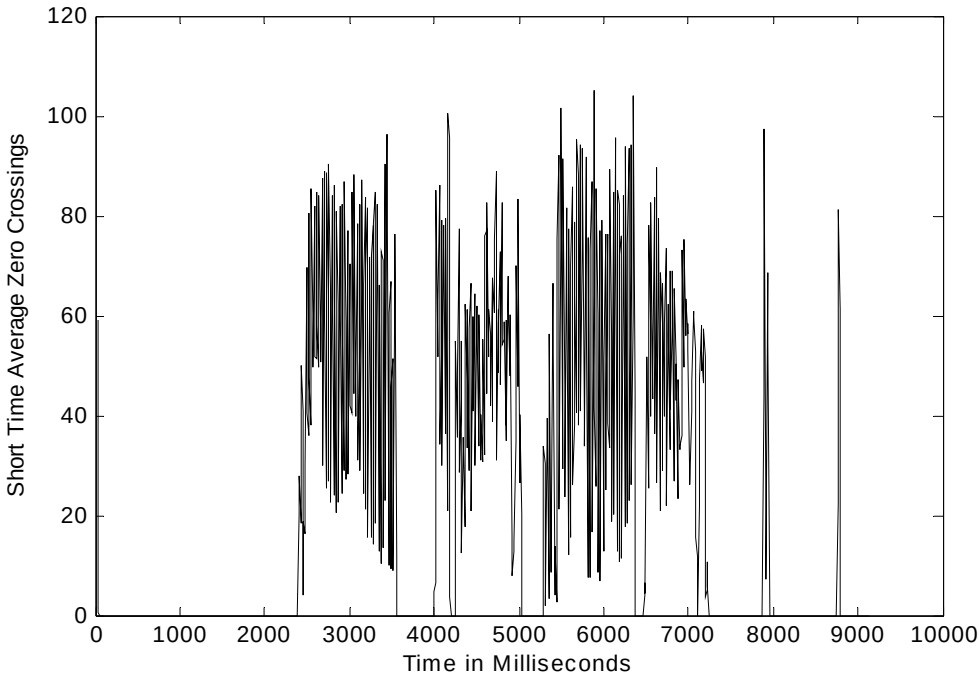

Fig 4.7. Short Time Average Zero Crossings for Neutral Sample

The waveforms of features viz-Cepstrum

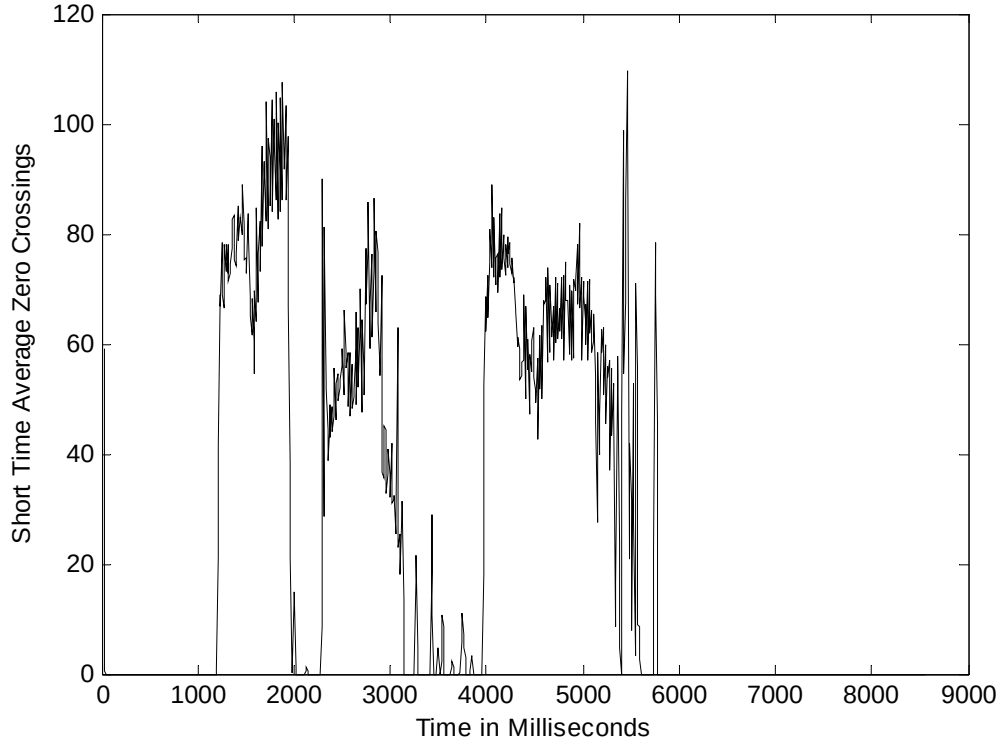

Fig 4.8. Short Time Average Zero Crossings for Strain Sample

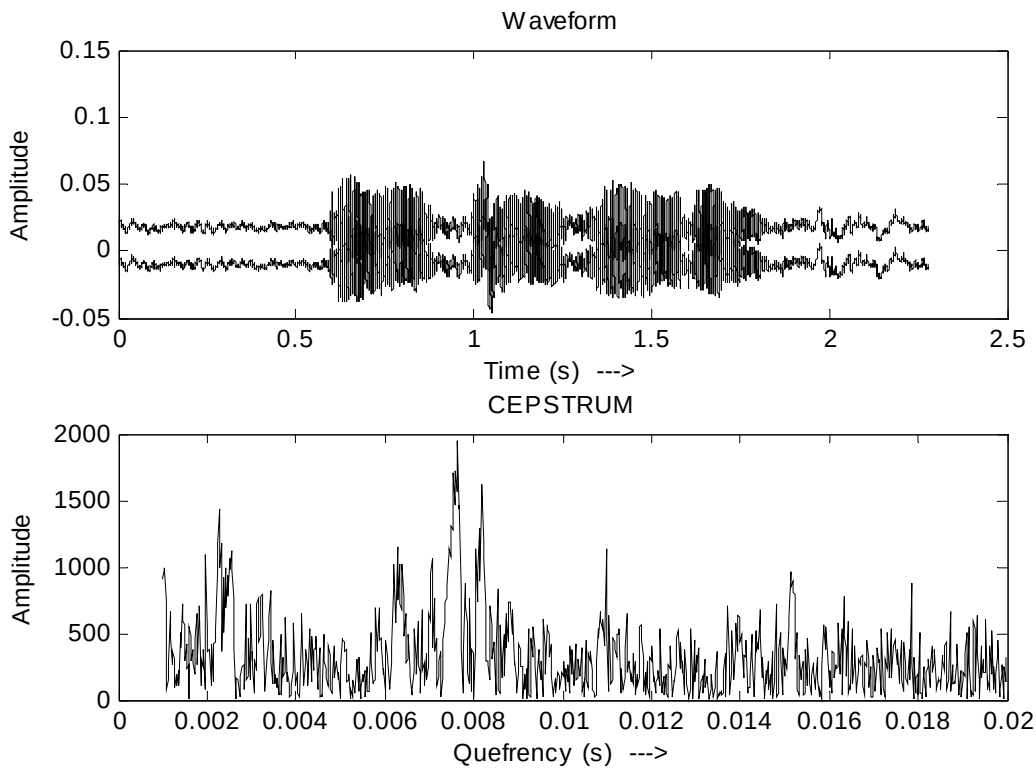

Fig.4.9. Cepstrum for Neutral Sample

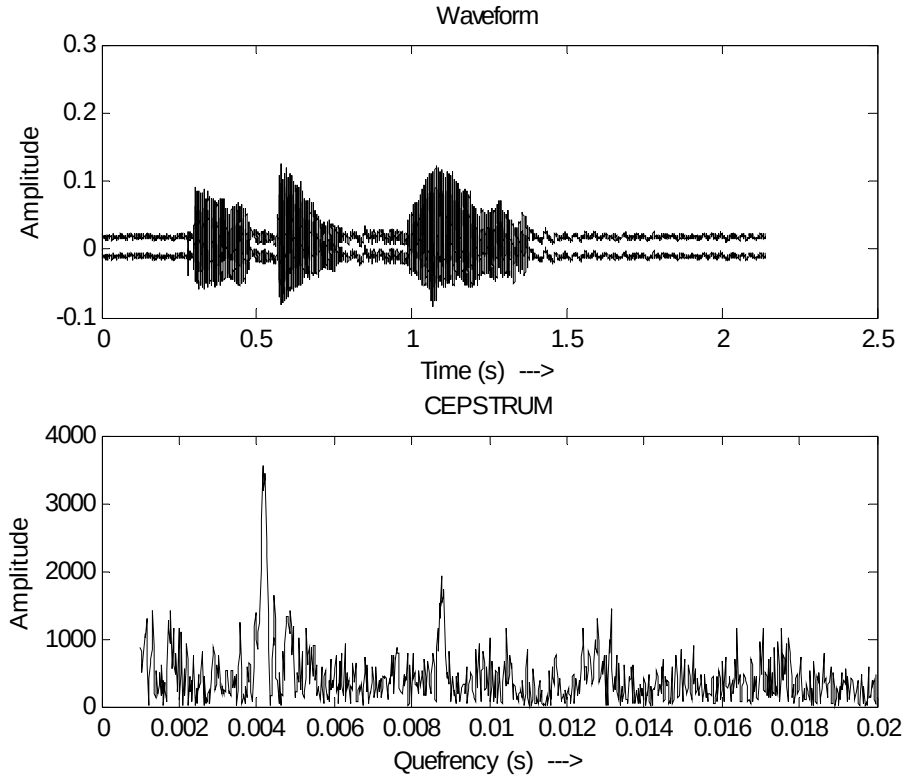

Fig.4.10. Cepstrum for Strain Sample

5. Results

This experiment uses phonetically rich sentences from the Exam Strain corpus for our psychoanalysis of strained speech. These sentences were automatically segmented into phoneme-like units. ANN does comparison of Neutral and Strain Sample. The results are shown below:

6. Conclusion

The Spectral Psychoanalysis of speech signal is aimed at extracting spectral features such as fundamental frequency, Short-time-energy, short-time-zero crossing, Spectrum, Cestrum, Spectral centroid etc. Changes in spectrum of speech signal have shown to be an indicator of the internal emotional state of a person. This research work, has extracted these spectral features of some speakers in neutral condition and under strain condition. This research has formed the feature matrix of the feature vectors obtained. For classification of the speech signal for strain Artificial Neural Network plays main role. The Standard Deviation of short –Time Energy is a reliable indicator of strain**.** Thus, the study concludes that spectral psychoanalysis is an efficient tool for detecting strain in speech in its various areas of applications. Spectral psychoanalysis can be used in the terrorism forensics.

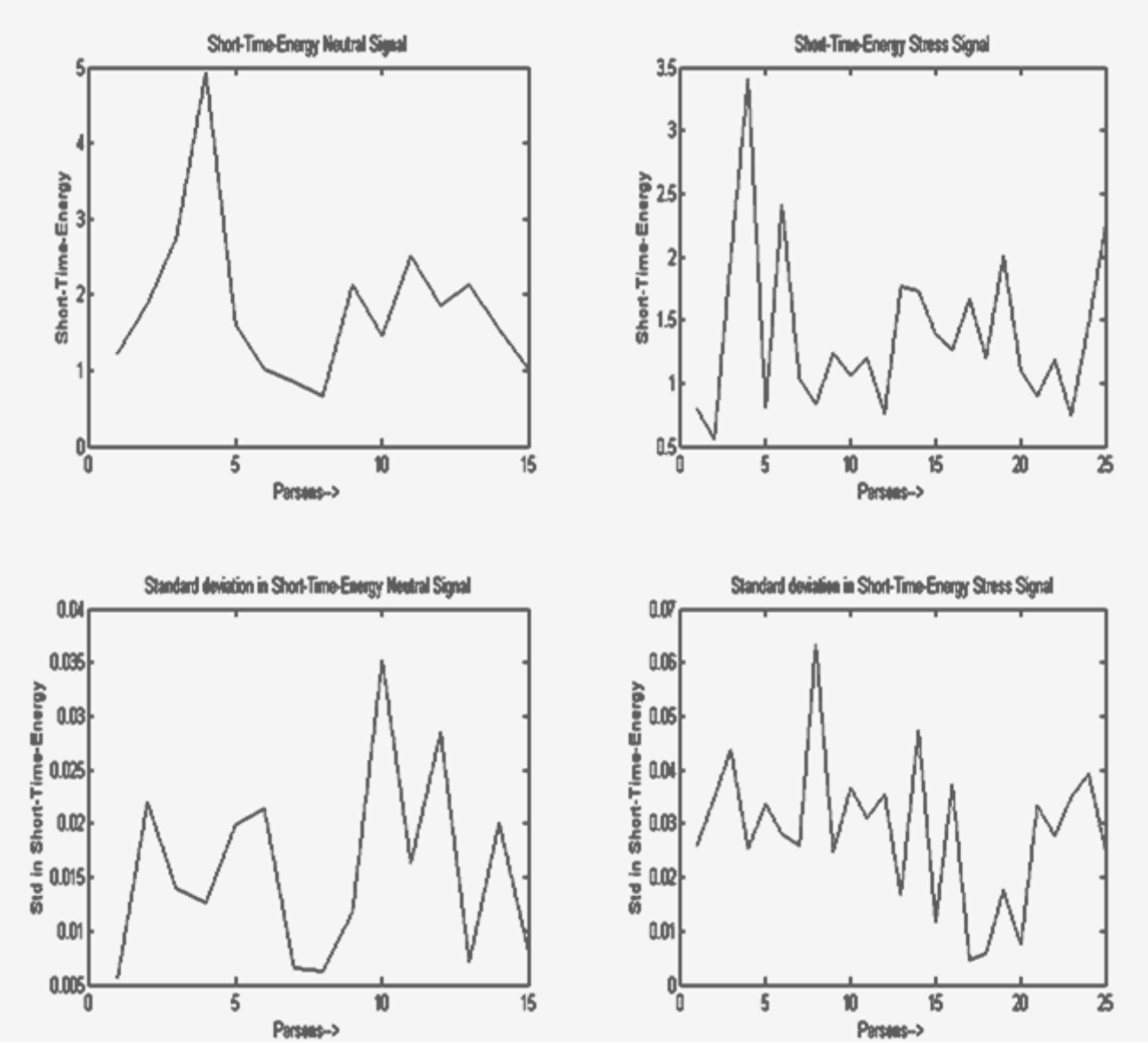

Fig. 4.11. Standard Deviation of short –Time Energy

7. References

Johnstone T and Scherer K (1999). The effects of emotions on voice quality. *Proceedings of 14th International Congress of Phonetic Science. San Francisco*. pp.2029-2032.

Levitt H and Rabiner LR (1971). Analysis of Fundamental Frequency Contours in Speech. *Journ. Acoust. Soc. Amer.* 49(2): 569-582.

Rule R (1969). Investigation of Strain Patterns for Speech Synthesis. *Rosenberg Journal Acoust. Soc. Amer.* 45(1): 92-101.

Schafer RW and Rabiner LR (1971). Design of Digital Filter Banks for Speech Analysis, *Proceedings of the Fifth Annual Princeton Conference on Information Sciences and Systems.* pp.40-47.

Ververidis D and Kotropoulos C (2006). Emotional speech recognition: Resources, features, and methods. *Speech Communication* 48(9): 1162-1181.

www.archive.org/stream/.../scopeofpsychoana012068mbp_djvu.txt

www.jkp.com/catalogue/tag/autism

www1.chapman.edu/~ruppel/ConferenceAbstracts.htm

www.humanities.uci.edu/critical/publications.html

www.eoneill.com/references/cotsell/chapter11.htm

Eth.J.Sci & Technol. 5(2):124-135, 2008 ISSN 1816-3378

Design of a Fuzzy Rule Base Expert System to Predict and Classify the Cardiac Risk to Reduce the Rate of Mortality

N Nalayini
Associate Professor, NGM College, Pollachi – 642 001, Coimbatore, TamilNadu, India: sandeep_nalayini@ yahoo.com, nakan4s1@yahoo.co.in

Abstract
The main objective of design of a rule base expert system using fuzzy logic approach is to predict and forecast the risk level of cardiac patients to avoid sudden death. In this proposed system, uncertainty is captured using rule base and classification using fuzzy c-means clustering is discussed to overcome the risk level, so that emergency care can be taken for the cardiac patients with high risk. To predict and classify the cardiac risk based on the controllable risk factors "blood pressure, cholesterol, diabetic, and obesity", which can be controllable, are taken as inputs for the expert system and the "risk level" of the patient is the output. The input triangular membership functions are Low, Normal, High, and Very High. The output triangular membership functions are Low, Medium, and Very High. The proposed system is used to incorporate the available knowledge into an expert system based on the clinical observations, medical diagnosis, and the expert's knowledge. The rule base system is validated with the captured data for accuracy and robustness using **MATLAB**. The results of the experimental analysis in finding significant patterns for heart attack prediction and classification are presented. The implementation of the proposed approach for identifying the cardiac risk level is done with VB.NET.Also, the simulated model using simulink may be generated for the expert system as further enhancement of this work.

Keywords: Cardiac Risk; Risk Factors; Fuzzy Rule Base; Clustering; Simulated Model

1. Introduction
Heart disease is the leading cause of death in the world. Despite dramatic improvements in both diagnosis and therapy, cardiovascular disease remains the leading cause of mortality in the developed world. The uncertain factors like inexact nature of equipment accuracy, inability to measure variables in a precise manner, vagueness in diagnosis, and undecidabilty of disease based on risk factors, of real world knowledge and human anatomy characterization raises the death rate day by day and year by year. Patients with high-risk disease like cardiac arrest require precaution and prevention as early as possible. But, due to the unexpected and sudden stop of the functioning of pumping muscular organ "THE HEART", the controllable risk factors blood pressure, cholesterol, diabetic, obesity to be maintained always at the normal level to regularize the adequate supply and normal flow of blood in the circulatory system, the sudden arrest can be avoided efficiently and effectively. Fuzzy Logic has proved to be a powerful tool for decision making and control systems to overcome the uncertainty. In this proposed system, fuzzy logic is applied (i) in the design of rule-base for controlling the risk factors,(ii) in clustering used to classify the risk level of cardiac patients, which helps to take important decisions with respect to the domain expert's knowledge.

i. The prime objective is to control the growth rate of mortality due to high risk disease like heart attack. This objective is attained by controlling the main four risk factors using the rule base system.
ii. Uncertainty is captured and implemented as a rule based knowledge system which is implemented using MATLAB. Rule base is constructed for all ranges specified for all the four risk factors. It is a generalized rule

based system so that rules can be formed for any patient with any one, two, three or all the four risk factors.

iii. Using Fuzzy c-means clustering the cardiac patients are clustered into various.
   - disease-wise, risk-wise and risk-factors-wise clusters
   - patients with risk variation clusters, so that emergency care may be given the first preference for treatment will help the expert to take the important decisions regarding the cardiac patients.

iv. Simulated version of rule viewer, 3D-surface view shows the final output value for the given input parameter values.

v. Structure of Fuzzy Inference System (FIS) for cardiac arrest is generated while checking, training and testing the data, which is used to know the output value based on the rules.

vi. Using VB.NET the forms are generated to calculate the risk level based on the weightages given to the parameters.

vii. Simulated model using simulink is generated, which shows, the functioning of fuzzy rule base expert system with rule viewer diagrammatically. This model shows the simulated view of the expert system in terms of modulating the value of risk factors as a further scope of this work.

2. Fuzzy Logic and Cardiac Arrest

Medical diagnosis is still considered to be an art even though there are so many standard methods, procedures and equipments available. Prediction is very difficult even by the experts, due to various uncertain factors, involves literally all of human ability including intuition and sub consciousness. The risk factors becomes a great risk due to inexactness of blood pressure and cholesterol, inaccuracy of obesity and overweight, imprecise nature of diabetic that promotes cardiac arrest which in turn leads to fatal end at an early stage itself. Hence, to capture and overcome the unexpected, unknown and uncertain cardiac arrest, the most powerful methodology closer to human decision making process is fuzzy logic. Using fuzzy logic the results can be yielded superior to conventional control algorithms. Also, it provides reasoning methods for uncertainty with appropriate inference. Fuzzy Logic is proved to be an efficient tool for intelligent and control systems in medical diagnosis (Kwang, 2005; Jayanthi and Wahidabanu, 2006).

3. Design and Validation of the Proposed Fuzzy Rule Base Expert System

The proposed system is designed and validated with a set of available knowledge source and sample data related to cardiac patients, to make the circulatory system, to supply normal and adequate blood flow without any abstraction and distraction. In this paper, (i) the design of rule base expert system provides the control procedure for controlling the risk factors to avoid sudden arrest of cardiac and (ii) the c-means clustering used to classify the patient's as various clusters in terms of risk factors, disease and treatment, helps to take correct decision in correct time to overcome the sudden death, which in turn reduces the rate of mortality.

3.1 Fuzzy Representation of Input and Output parameters as Membership Function

In this phase, fuzzy sets are constructed for the risk factors, is considered for the evaluation based on Universe of Discourse as Linguistic Variables for input as well as output parameters. The controllable risk factors considered in the proposed expert system are Blood Pressure, Cholesterol, Diabetic, and Obesity as input and the risk level is the output. Fig. 3.1 represents the input parameter Blood Pressure as triangular membership function.

3.2 Rule Base

Rule base is the heart of the proposed expert system. The acquired knowledge from medical experts is converted into rules in the form 'If-Then' for easy understanding and to overcome the uncertainty in a friendly way. Sample rule for the system is "If [Blood Pressure is Low] and [Cholesterol is Low] and [Diabetic is Low] and [Obesity is Low] then [Risk Level is Low]".The constructed rule base system for the proposed system consists of 256 rules using the formula nm – where n – is the number of fuzzy sets with linguistic variables which are Low, Normal, High, Very High and m – is the number of risk factors which are blood pressure, cholesterol, diabetic, obesity. In this paper n=4, m=4, so 44=256 rules (Gedeon et al., 2001; Fabrizio et al., 2008). Table 3.1 represents a part of 256 rules framed for the rule base system.

Like blood pressure the membership functions are constructed for other risk factors also (Fig. 3.2).

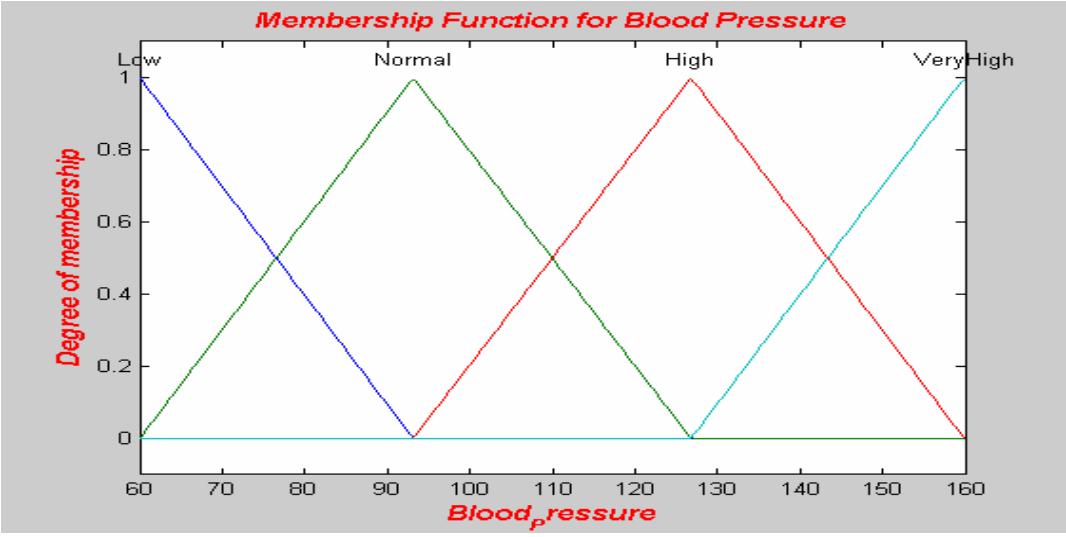

Fig. 3.1. Membership function for Blood Pressure

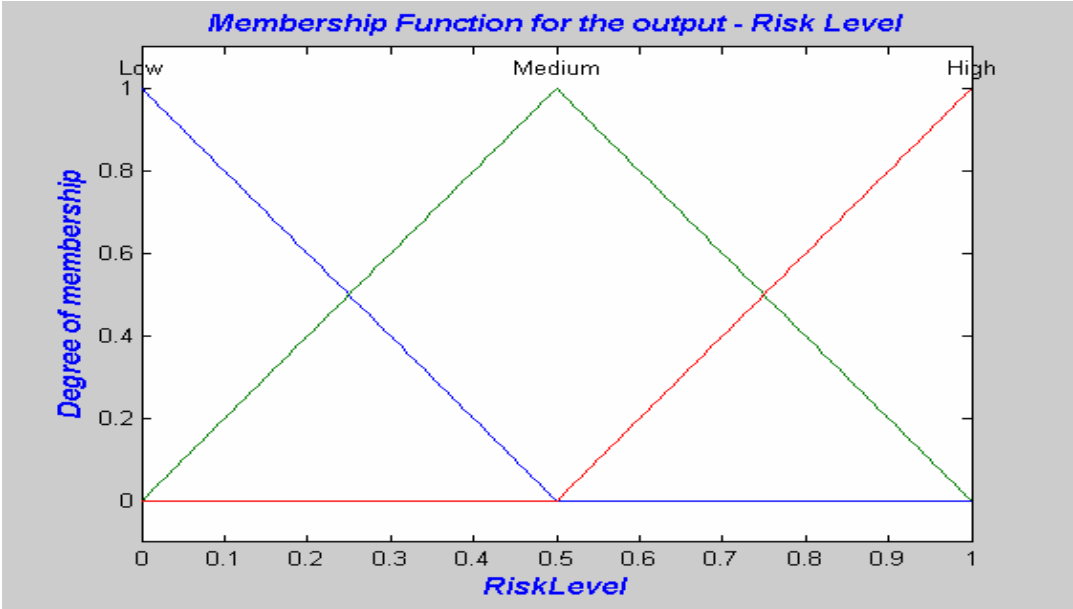

Fig. 3.2. Membership function for the output parameter Risk Level

Table 3.1. Sample Rules framed for the Proposed System

	IF				THEN
Rule No	Blood Pressure	Cholesterol	Diabetic	Obesity	Risk Level
1	Low	Low	Low	Low	Low Risk
2	Low	Low	Low	Normal	Low Risk
3	Low	Low	Low	High	Low Risk
4	Low	Low	Low	Very High	Low Risk
5	Low	Normal	Low	Low	Low Risk
6	Low	Normal	Low	Normal	Low Risk
7	Low	Normal	Low	High	Low Risk
8	Low	Normal	Low	Very High	Low Risk
9	Low	High	Low	Low	Medium Risk
10	Low	High	Low	Normal	Medium Risk
11	Low	High	Low	High	High Risk
12	Low	High	Low	Very High	High Risk
13	Low	Very High	Low	Low	High Risk
14	Low	Very High	Low	Normal	High Risk
15	Low	Very High	Low	High	High Risk
16	Low	Very High	Low	Very High	High Risk

3.3. Decision Making Logic Component

In this phase, the decision rules are constructed for input parameter and control output values to find the active cells, so that what control actions can be taken as a result of firing several rules and finally the aggregation of minimum control outputs are taken into consideration, to maximize the grade of output to resolve the uncertain linguistic input to produce crisp output. There are four inference methods are available. In this proposed system "MAMDANI INFERENCE METHOD" is considered. The Inference System generated for the proposed system using MATLAB is shown.

3.4. Defuzzifier: converts fuzzy values into crisp values

Defuzzification is a process to get a non-fuzzy control action that best represents possibility distribution of an inferred fuzzy control action. Unfortunately, there is no systematic procedure for choosing, a good defuzzification strategy, thus, by considering the properties of application case any one of five methods available can be selected for defuzzification methods. In this study, the **"Mean Of Maximum"** defuzzification method is applied to find the intersection point of $\mu = 2/5$ with the triangular fuzzy number $\mu_L(rl)$ and $\mu_M(rl)$ in the defined equation Substituting $\mu = 2/5$ into$\mu = (rl-- 6)/6$, $6\mu = rl-6$, $6\mu + 6 = rl$, $6*2/5 + 6 = 8.4$. --- (1)

$\mu = (36 – P) /20$, $20\mu = 36 – P$, $20\mu -- 36 = --P$, $20 *2/5 -- 36 = -- 24$, $P =24$. ----(2).

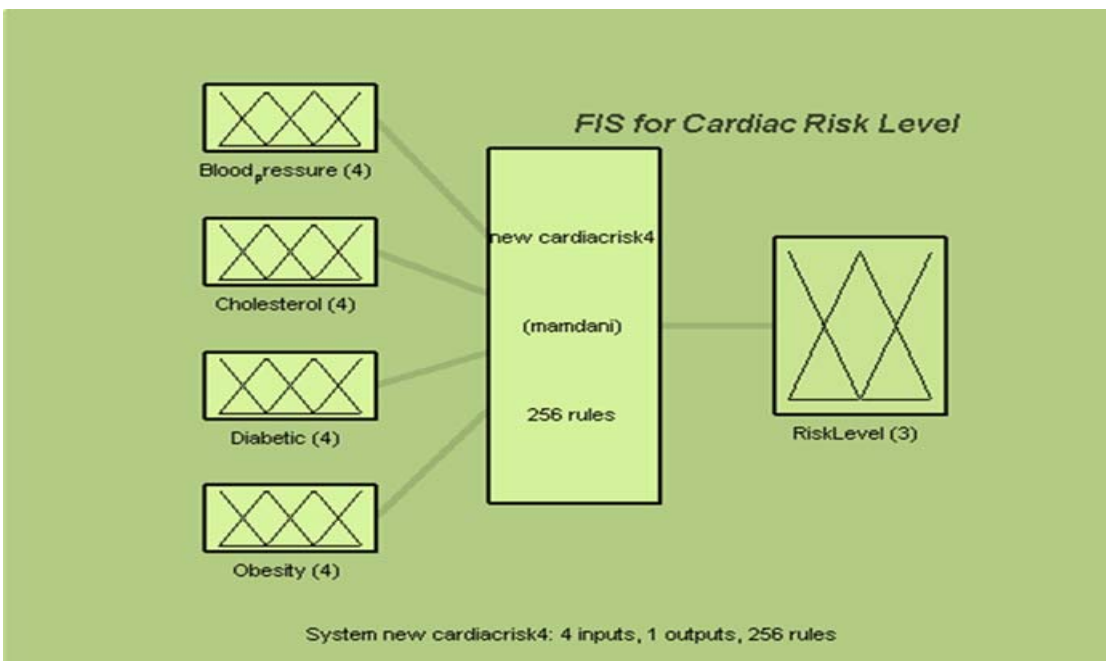

Fig. 3.3. Inference system generated in MATLAB with rule base constructed

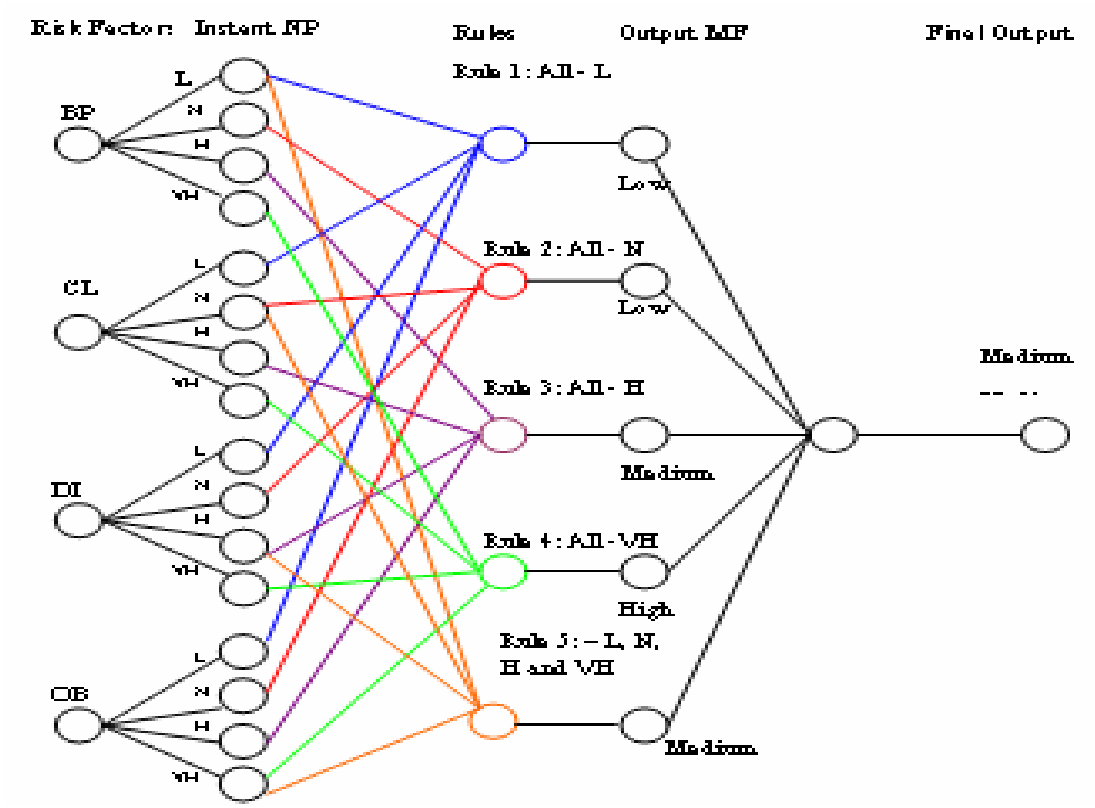

Fig. 3.4. Structure of FIS generated – training and testing the sample data

Correspondingly the values are $\zeta 1 = 8.4$, $\zeta 2 = 24$. The period of life time in terms of crisp output is $Zm^* = 8.4+24/2 = 32.4/2 = 16.1 = 16$. ----- (3) The medium risk level membership function. Hence, according to the value applied $\mu = 2/5$ the risk level to be considered as **"MEDIUM"** (i.e.) the patient can survive for about 60 months. Therefore, it is evident to prove that, how a Fuzzy Rule base Expert System (FRBES) is used to control the controllable risk factors to regularize the blood flow, how a patient can control the contributing factors of inactivity, to find the life time of postponement of attack, to protect the patient from high risk of cardiac arrest, to cluster the patients according to risk level, to minimize the sudden death at maximum duration to reduce the rate of mortality (Waldock et al., 2000; Vig et al., 2005**.**

4. Results

In order to validate the proposed fuzzy rule based system,

i. The simulated version of 256 rules constructed is shown in the Fig. 4.1.1 rule-viewer, and in Fig. 4.1.2 surface viewer.

ii. inferences which are made based on the rules constructed are shown in the Fuzzy Inference System in Fig. 3.3 as well as in the structure generated for the FIS in Fig. 3.4

iii. variations in the risk factors are shown in the form of clusters while checking, training and testing the data as disease-wise, risk-wise, etc…is shown in Fig.4.3.2

iv. The above mentioned results are useful in monitoring the modulation

of risk factors reading, which varies from patient to patient with risk level of heart attack, which in turn helps to control sudden attack

4.2. Surface View of Mapping with Input Parameters Vs Output Parameters

Along with the rule-viewer, 3D surface view can also be generated for the entire input variable with output variable. (i.e.) Blood Pressure Vs cholesterol, Diabetic, Obesity and Cholesterol Vs Blood Pressure, Diabetic, Obesity, like-wise totally, 12 surface view for the inference system is generated. Some of them are shown here.

4.3. Grouping of Patients Data According to the Risk Factors as Clusters

Cluster analysis is a way to examine similarities and dissimilarities of observations or objects. In this proposed FRBES, cluster analysis is used for the purpose of clustering the patients risk-wise (low, medium, high), disease-wise (atherosclerosis, angina, heart attack, congestive heart failure),treatment-wise (Blood cholesterol lowering medications, bypass surgery, coronary angioplasty). Grouping of clusters are used to identify the patients who need the emergency care. Using **MATLAB**, the membership functions are shaped by training them with input/output data rather than specifying them manually (Kwang, 2005; Pach and Abonyi, 2006).

4.1. Micro View of Simulated Rule Base

Rules simulated using rule-viewer

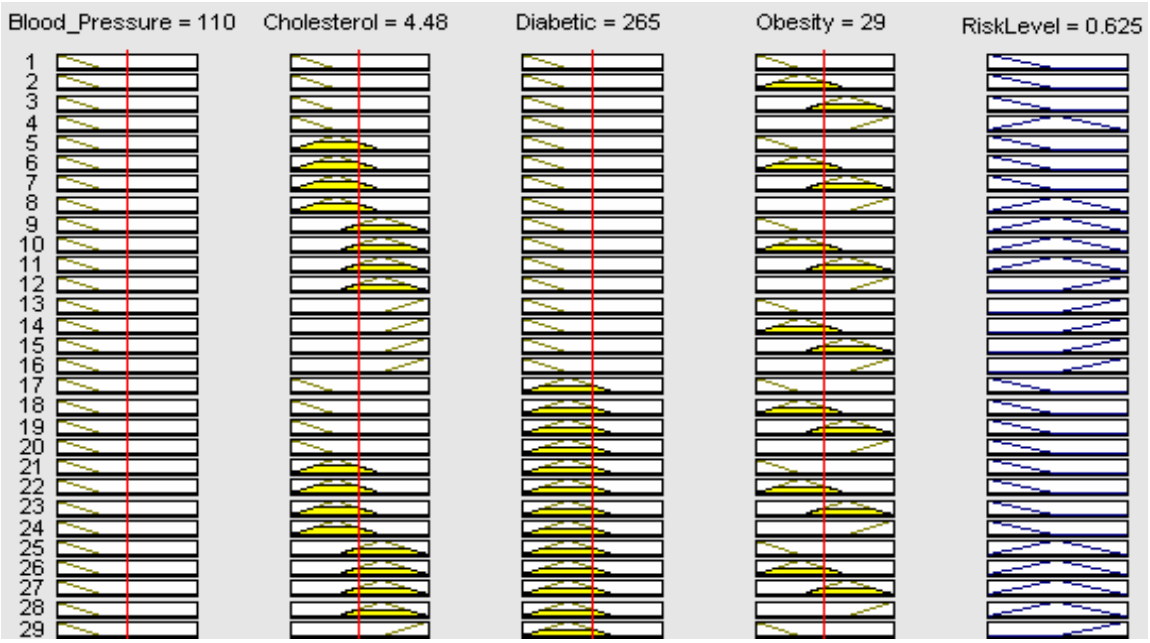

Figure 4.1.1 Simulated view of rule base

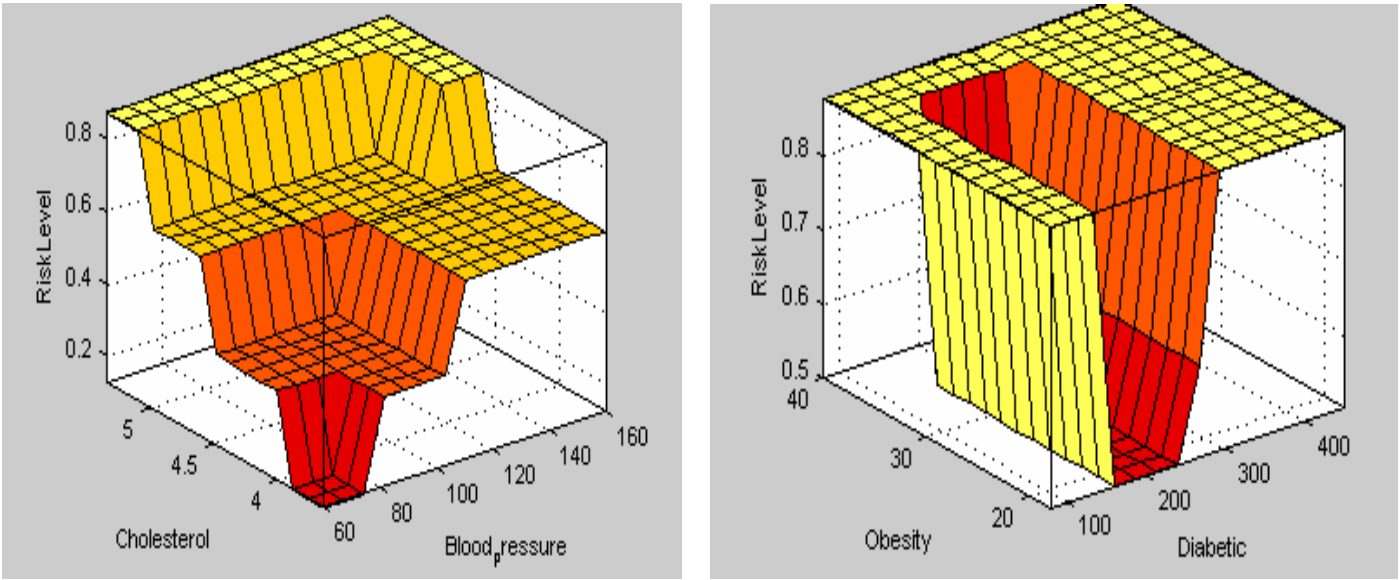

Fig. 4.1.2. Simulated surface-view of the rule base

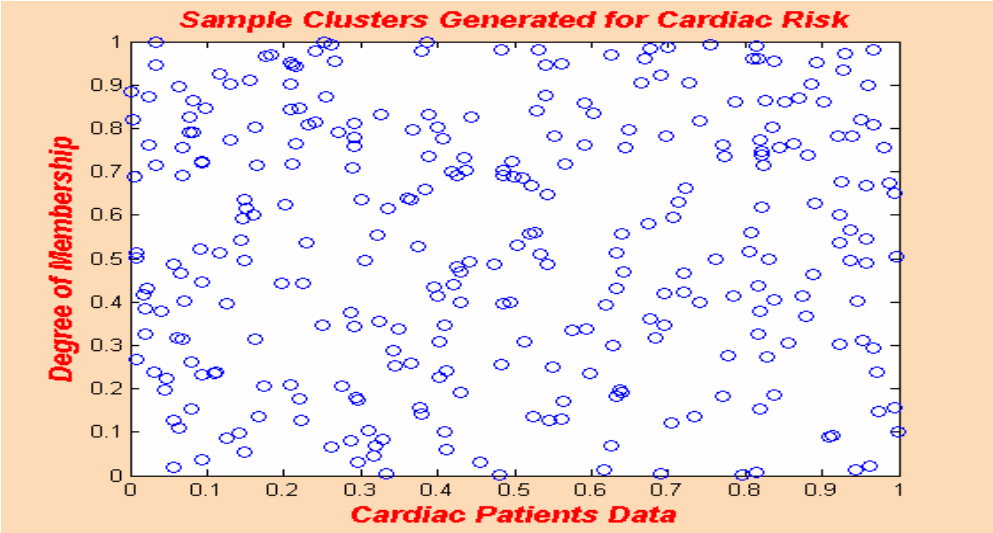

Fig 4.3.1 Generation of Clusters for the Fuzzy Inference System of Cardiac Arrest

4.4. Generation of FIS for Cluster Shape Preservation Using Adaptive Neuro-Fuzzy Inference System (ANFIS)

Using the Adaptive Neuro-Fuzzy Inference System (ANFIS) Editor, shaping of membership functions are done by training them with input/output data rather than specifying them manually. The shape preservation is applied to organize the same size and shape clusters, to maintain the characteristics and properties of data in such a way to identify and differentiate the patient's risk level for emergency treatment.

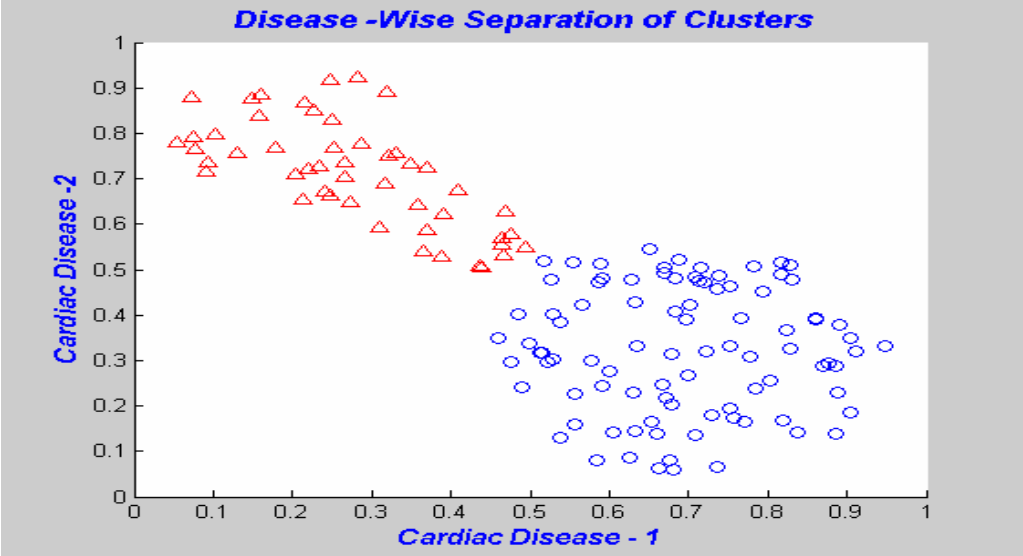

Fig 4.3.2 Grouping of Cardiac Disease-Wise Clusters

5. Testing the risk level of cardiac patients based on the parameters using VB.NET

Based on the medical expert's knowledge, medical domain, various journals and magazines, the parameters specified in the table were given weightages and fuzzy values to identify the nature of the risk level, so that high risk patients can be given preference for the treatment. This testing can be done with any number of risk factors for identification of risk level for any disease. Only problem is the risk factors has to be found out properly. The weightages and fuzzy values should be assigned carefully.

6. Conclusion and Scope for Further Research

In this paper, the benefits of Fuzzy Rule Base Expert System (FRBES) with fuzzy C-Means clustering in prediction of cardiac risk have been successfully demonstrated. This system maybe used as an aid for medical practitioners to save time. The central contribution of this paper is the design of the fuzzy rule base system, to identify the high risk cardiac patients so that the sudden death can be avoided by controlling the controllable risk factors. The validation of the FRBES is used to determine the low risk, medium risk and high risk patients to decide about the type of treatment. This novel idea successfully has been implemented using MATLAB. Even though there are many expert systems available for prediction of heart disease, the proposed expert system is used for maintaining the all the four risk factors at normal condition simultaneously, to avoid the sudden stop of cardiac. (Berrón and De Abreu-García, 2005).

In this study the results shown by the cardiac fuzzy inference system designed helps the experts to determine the duration period, for treating the patient depending upon the output parameter risk. level. This fuzzy inference system may be taken as a sample to develop new FIS for treatment of other illness also effectively.

In the absence of medical diagnosis evidences, it is difficult for the experts to opine about the grade of disease with affirmation.

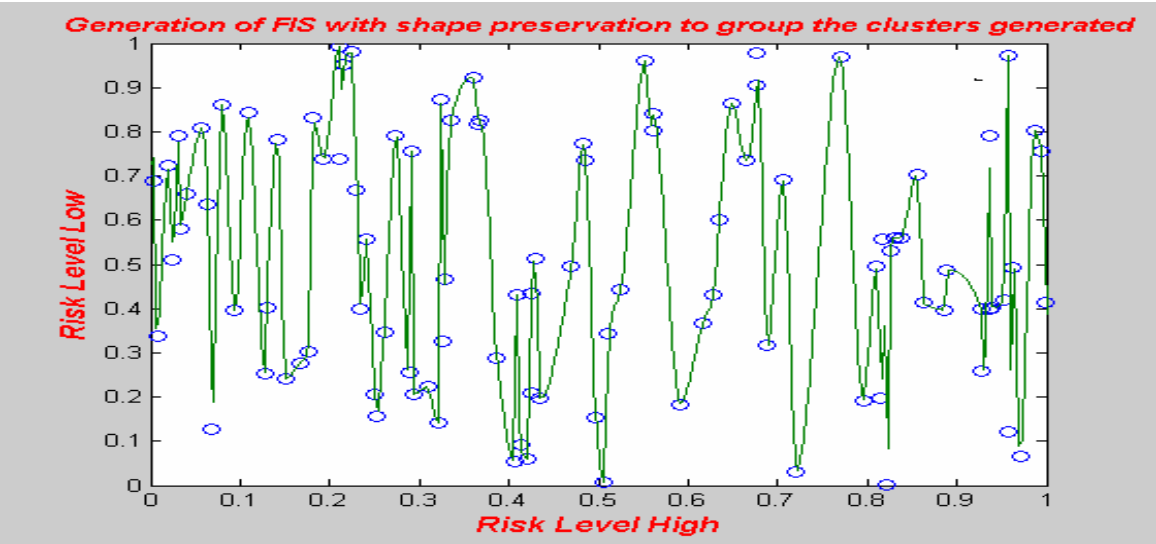

Fig. 4.4.1. Shape preservation of Cardiac Arrest Fuzzy Inference System

There is a need to undertake diagnostic studies medically to construct more realistic fuzzy numbers for characterizing the imprecision and there by fuzzily describing the patients nature of disease. Hence, predicting the cardiac risk level may be monitored by designing a simulated model for watching the pumping rate of heart with normal heart beat, changing lifestyle, environment, and food habit may be considered as the further extension of this work. Also the noise can be deducted and the medical errors can be reduced.

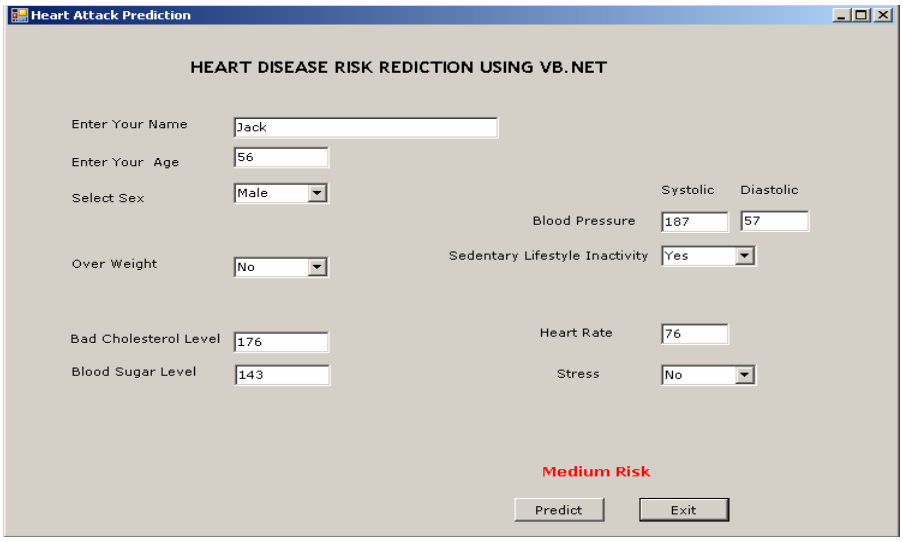

Fig. 5.1. Identification of Risk Level using VB.NET

Table 5.1. Weightages and Fuzzy Values for the Parameters

Parameters	Weight age	Fuzzy Value
Bad Cholesterol	Very High > 200	0.9
	High 160 to 200	0.8
	Normal < 160	0.1
Blood Pressure	Normal (130/89)	0.1
	Low (<119/79)	0.8
	High (>200/160)	0.9
Blood Sugar	High (>120&<400)	0.5
	Normal (>90&<120)	0.1
	Low (<90)	0.4
Overweight (obese)	Yes	0.8
	No	0.1
Male and Female	Age < 30	0.1
	>30 to <50	0.3
	Age>50 and Age<70	0.7
	Age >70	0.8
Sedentary Lifestyle/Inactivity	Yes	0.7
	No	0.1
Heart Rate	Low (<60bpm)	0.9
	Normal (60to100)	0.1
	High (>100bpm)	0.9
Stress	Yes	0.7
	No	0.1

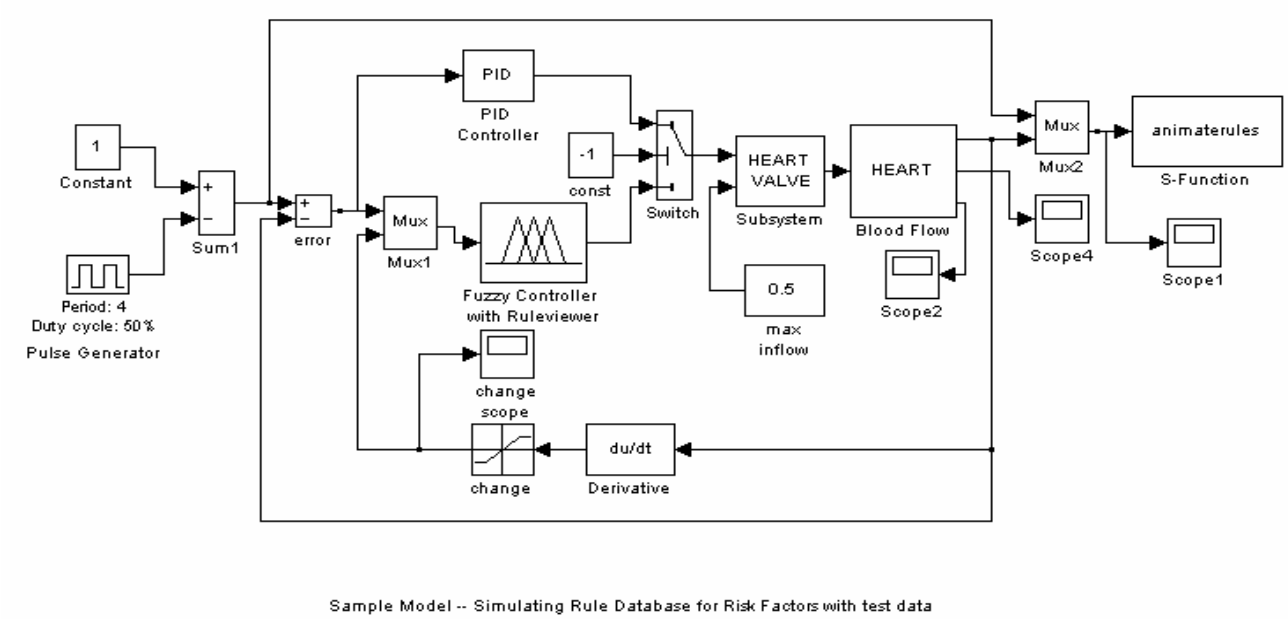

Fig. 6.1. Simulated model: Cardiac Risk Level

7. References

Berrón C and De Abreu-García JA (2005). Fuzzy Logic Control of a Cardio Pulmonary. Bypass Rotary Blood Pump *From Proceedings (485) Biomechanics, ACTA Press.*

Fabrizio A , Edoardo G, Stefano P, Cesare A (2008). A Fuzzy Logic approach to decision support in medicine. Kell s.r.l., Via E.Q. isconti, 8 00193 Rome Italy. *Clinical Cardiology and Hearth Failure Unit, Dept. of Cardiology, Humanitas Clinical Institute, Via A. Manzoni, 56, Rozzano, Italy.*

Gedeon TD, Kok WW, Tikk D (2001). Constructing Hierarchical Fuzzy Rule Bases for Classification. *IEEE International Fuzzy Systems Conference.* 3:1388-1391.

Jayanthi B and Wahidabanu RSD (2006). A non-invasive study of alterations of the carotid artery with age using ultrasound images. *Medical & Biological Engineering & Computing.* 44(9): 767-772.

Kwang HL (2005). First course on fuzzy theory & applications. *First Edition, Springer India LTD, New Delhi.*

Pach FP and Abonyi J (2006). Association Rule and Decision Tree based Methods for Fuzzy Rule Base Generation. *World Academy of Science, Engineering and Technology 13.*

Parthian L and Subramanian R (2007). Intelligent Heart Disease Prediction System using CANFIS and Genetic Algorithm. *International Journal of Biological and Medical Sciences 3:3*

Szpunar-huk E (2004). Problems of Medical Data Mining, *Journal of Medical Informatics & Technologies.* 7: 91-98

Vig R, Handa NM, Bali HK and Sridhar (2005). Fuzzy Diagnostic System for Coronary Artery Disease. *Department of Telecommunications and IT, University Institute of Engineering and Technology, Chandigarh, PGIMER Chandigarh, India IE (I) Journal-ID 85*

Waldock A, Brian C, Melhuish C (2000). A Hierarchical Fuzzy Rule based Learning System based on Information Theoretic Approach. *Intelligent Autonomous System Laboratory, University of the West of England, Bristol, UK.*

Eth.J.Sci & Technol. 5(2): 136-141, 2008 ISSN 1816-3378

Performance Analysis of Throughput at Bahir Dar University LAN

Prathap M[1] and E Chandra[2]
[1]*Department of Computer Science and Engineering, Bahir Dar University, Bahir Dar Ethiopia: prathaparthi@yahoo.co.in*
[2]*Asst Prof and Head, D.J .Academy for Managerial Excellence, India: crcspeech@gmail.com*

Abstract
It is obvious that the network performance cannot exceed the hardware capacity. Frequent up gradation of hardware is not possible in order to achieve high performance. Hence changes are needed in the technical modification, which helps economically. Computer scientists and network users have discovered that standard TCP does not perform well in high bandwidth delay environments. As a model, the Local Area Network of Bahir Dar University Engineering Faculty was tested and reported. . In this paper, we explore the challenges of achieving high throughput over real environments. Moreover, various performance factors like Delay, Throughput, Network capacity, Available and achievable performance were studied and discussed. Comments were made on decreasing delay factors and better solutions were recommended for buffer management.

Keywords: TCP; delay; throughput; available and achievable performance

1. Introduction
The network performance characteristics like delay, throughput were measured and studied. Due to congestion, the delay increases The Local Area Network of Bahir Dar University was chosen for this case study and data readings were noted by varying the number of users. The users vary in using the network from time to time. It was concluded that when the users are more the traffic is more and the delay increases resulting in slower transmission of bits. Though TCP/IP had gained much importance, the standard TCP does not perform well in high bandwidth delay environments (Kelly T, 2003). Trans-port Control Protocol (TCP) is a reliable, end-to-end, transport, protocol that is widely used to support applications like telnet, ftp, and http (Stevens W. R, 1994). Kelly's Scalable TCP on real networks with a set of systematic tests using different network were already tested (Li Yee-Ting et al, 2004). This paper analyzes these factors and reports the necessary improvements needed for controlling congestion thereby improving performance.

2. Delay
Delay is the time taken for a bit to travel form one end to another which could be measured in seconds or fraction of seconds. Delay may differ slightly depending on the specific pair of computers. The first important property of networks that can be measured quantitatively is delay.

2.1 Throughput
The second fundamental property of networks that can be measured quantitatively is throughput. Throughput is a measure of the rate at which data can be sent though the Network, and is usually specified in bits per second (bps) or measure of the network capacity. When the network is idle, the number of users is kept as zero and when the network is functioning with maximum numbers of users, it is taken as one. If the numbers of users are half, then the network usage is also half. The Delay and throughput factors are analyzed and the effective delay is given by $D = D_o / (1-U)$ where D_o is the network is idle and U is the Utilization.
When U = 0,

$$D = D_o / (1-U), D= D_o$$

When U = 1/2,

$D = D_o / (1-U)$, $D= 2D$
When $U = 1$,
$D = D_o / (1-U)$, $D= \infty$

Table 1. Effect of delay

Users in Percentage	Status of delay
0	Minimum
50	Twice
100	Maximum

If the network is idle then the effective delay D will be D_0. When the network is utilized to half of its capacity then the effective delay will be twice and when the all the users are utilizing the effective delay becomes infinity. As the number of users are close to the maximum then delay increases rapidly to maximum as shown in Table 1. This shows clearly that as the delay increases the traffic increases, resulting the bit in slower transmission.
As the users increases the delay increases which shows that they are directly proportional. The volume V is given by $V = T \times D$

Hence, D=V/T
Hence in order to make the delay D to minimum, either the volume of data has to be decreased or increase the throughput. We conclude that if the congestion is less then the throughput increases.

Table 2. Data showing the flow of bits

Time	Received	Sent
06:06	546	2101
06:07	866	2757
06:08	1038	3136

Table 3. Throughput analysis

T	Minimum		Maximum	
	Received	Sent	Received	Sent
Bits/sec	6.31	2.86	10.93	5.33

Congestion Control algorithm can be used so that the data traveling in the less congested medium will transmit faster. To measure the delay, the client machine of the faculty is connected to the server through two switches and the readings were noted as shown in Table 2. Based on the delay of bits transmission throughput was calculated per second.

The configuration of the network server used is
Pentium IV 1.76 GHz

128 MB of RAM

20 GB of Hard disk

The Client 1 configurations used are as follows:

Pentium IV 2.0 GHz

256 MB of RAM

Intel PRO/100 VE Network Connection

The server having an Internet Connection with proxy is allowed to enter the common sites of www Viz., www.google.com and the timing is noted on the client machine and the data transfer rate is given in table 2.

Based on the readings from Table 2 and the time difference, the Minimum and Maximum Received and sent bits per second were calculated and the results are shown in Table 3. The percentage of change in received and sent bytes are 54 and 57 respectively.

In theory, the delay and throughput of a network are independent but they may be related.

As shown in table 3, the bits per second varies while they are sent and received. If a bit slows down in a network, it leads to cause congestion. Hence data entering a congested network will undergo longer delay than data entering an idle network. For this, as shown in Fig. 1 the time interval between each bit is monitored. If for any reasons, the bit slows down we propose an algorithm based on congestion control. In order to control the congestion in the medium, the data has to be accelerated with free movement and less delay. This algorithm could be used for traffic management and algorithm in Fig. 2 is used for buffer management. In order to manage the buffer efficiently and reduce the time for reading the bits, this buffering concept could be implemented. Fig. 3 shows the situation after the buffers are created. These buffers are named as b1 and b2. After the second block has been read, the pointer P is set to the first record in buffer b1. The pointed bit positions are sent and the pointer is incremented till the end of the buffer. After sending the last bit then the pointer is moved to the first bit of buffer b2. This process is repeated until the last bit is sent. During sending process of the buffer b2 the buffer b1 is loaded. Hence, while the buffer b2 is sending, b1 is receiving bits both at the same time. Also after b2 is loaded b1 becomes empty and they interchange their functions. When the queue is empty, all the buffers and pointers are deleted. This helps in efficient time and memory management

3. Measuring Available Bandwidth

Available bandwidth is network capacity minus utilization (C-U). After performing TCP tuning techniques, a user or developer might think that they have fully utilized available bandwidth (Tierney, 2001).

```
get time interval
monitor bit transmission
if previous bit slows down then
   place previous bit in buffer
time slice of each bit is set by the receiving entity
if time slice expires and the bit not reached
request retransmission
check buffer and select the bits for retransmission
send only missing bits which ensures faster transfer of data.
```

Fig. 1. Algorithm used for shorter delay

```
name previous buffer as b1, next incoming buffer as b2
Repeat
   load b1 and b2 with octet of bit
   set pointer to b1.
     Repeat
          send pointed bit of b1
          move pointer to next bit
     until last bit of b1.
 If last bit sent is equal to 8 set pointer to bit 9 of b2
     Repeat
          send pointed bit of b2
          move pointer to next bit
     until last bit of b2.
 If last bit sent is equal to 2 times of 8 set pointer to bit 1 of b1
Until the buffer queue is empty.
```

Fig. 2. Buffer Management

However it is obvious that it is impossible that they are only utilizing the bandwidth that their application is capable of achieving, and not all the available bandwidth. Moreover functional, scalable network, could be upgraded in future according to the necessity of the bandwidth required results in Quality network, (Prathap and Chakravarthi, 2005). When the available bandwidth is unknown, TCP can be used to achieve the best performance.

TCP often does not perform well in high bandwidth long delay paths, due to the fact that it recovers very slowly from packet loss. Hence if we know the Maximum Burst Size (MBS — the maximum number of bytes that can travel through a network path without causing packet loss), both of those mechanisms potentially violate the fairly sharing policy of network resources. The knowledge of the MBS can aid in optimal and fair use of the network. We recommend for the use of tools like netest which is designed to provide information about each element on a path between two end hosts (Guojun and Tierney, 2003).

This information includes the available bandwidth of the path and/or the maximum achievable throughput. Netest can help to identify the source of poor network performance such as a problematic router, sending host, receiving host, lack of TCP buffers, etc. Netest also provides advice on what one can do to improve application throughput.

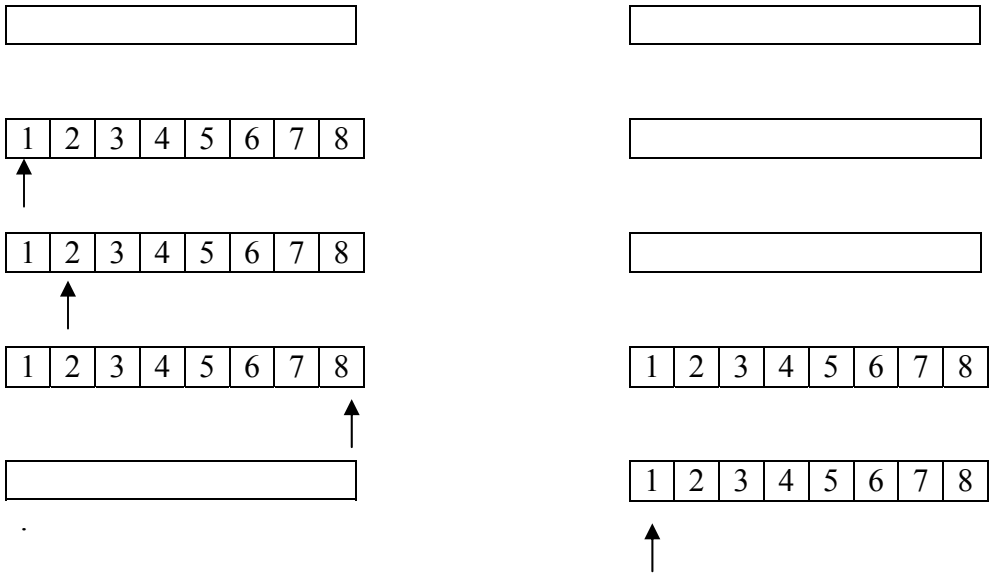

Fig. 3. Buffer b1 and b2 with pointer

Table 4. Data showing the flow of bits

Time	Received
06:06	946
06:07	1340
06:08	1561

4. Conclusion

The network performance factors delay and throughput were discussed and measured. The data collected showed that the congestion is more and hence the delay. This resulted in affecting the performance of the network. Using the above algorithms, the network performance could be tuned which results in shorter delay and faster transmission of bits. Also the network should include tools like Netest which helps in monitoring the bad performing hardware and provides way for better performance. The results obtained are shown in Tables 4 and 5 considering only the receiving bits.

The time and the number of users are kept as that of Table 2 and the data transmission readings were noted. Received bytes increased by 23% as compared to Table 2.

Table 5 clearly shows that the Throughput increased as compared to Table 3. Hence we conclude that the algorithm above can be used in order to control the congestion and accelerate the transmission.

5. Acknowledgements

We thank the Engineering Faculty of Bahir Dar University for providing the server resource and hence for data collection. Our sincere thanks to Ato Zenebe, the network administrator for his timely support

Table 5. Throughput analysis

T	Minimum		Maximum	
	Received	Percentage improved	Received	Percentage Improved
Bits/sec	3.68	28	6.56	23

6. References

Kelly T (2003). Scalable TCP: Improving Performance in High Speed Wide Area Networks. *First International Workshop on Protocols for Fast Long-Distance Networks. Geneva, Switzerland*

Stevens WR (1994). TCP/IP Illustrated. Volume 1, Addison Wesley. The Protocols. Addison-Wesley.

Li Yee-Ting, Dallison S, Hughes-Jones R, Clarke P (2004). A Systematic Analysis of High Throughput TCP in Real Network Environments. *Paper Presented* at *the Second International Workshop on Protocols for Fast Long-Distance Networks, Argonne National Laboratory, Argonne, Illinois USA-DataTAG-Final-Dissemination-D5.5-1.0.doc*

Tierney B (2001). TCP tuning guide for distributed application on wide area networks. *USENIX & SAGE Login*. 26(1): 33

Prathap M and Chakravarthi R (2005). A Systematic Methodology for Effective Implementation of Local Area Network (LAN*). Proceedings of the 23rd Annual May Seminar of Bahir Dar University Bahir Dar, Ethiopia.*

Guojun J and Tierney B (2003). Netest: A Tool to Measure the Maximum Burst Size, Available Bandwidth and Achievable Throughput. *Proceedings of the 2003 International Conference on Information Technology August 10-13, 2003, Newark, New Jersey, LBNL-48350*

Eth.J.Sci & Technol. 5(2): 142-145, 2008 ISSN 1816-3378

Techniques and Assessment of Small Business Capital

S Raja Narayanan and D Arthi
College of Business and Economics, Bahir Dar University, Ethiopia

Abstract
All businesses must have capital in order to purchase assets and maintain their operations. In general there are two types of capitals. In the case of debt capital, the cost is the interest rate that the firm must pay in order to borrow funds. For equity capital, the cost is the returns that must be paid to investors in the form of dividends and capital gains. The small business owners to determine a target capital structure for their firms. As a rule, the cost of capital for small businesses tends to be higher than it is for large, established businesses. The capital structure concerns the proportion of capital that is obtained through debt and equity. The optimal capital structure is the one that strikes a balance between risk and return and thereby maximizes the price of the stock and simultaneously minimizes the cost of capital. When evaluating a small business for a loan, lenders ideally like to see a two-year operating history, a stable management group, a desirable niche in the industry, a growth in market share, a strong cash flow, and an ability to obtain short-term financing from other sources as a supplement to the loan.

Keywords: Capital; Debt; Equity; Stock

1. Introduction
Capital, in the most basic terms, is money. All businesses must have capital in order to purchase assets and maintain their operations. Business capital comes in two main forms: debt and equity. Debt refers to loans and other types of credit that must be repaid in the future, usually with interest. In contrast, equity generally does not involve a direct obligation to repay the funds. Instead, equity investors receive an ownership position which usually takes the form of stock in the company.

2. Materials and Methods
This article is generally empirical and review in nature. This was basically to describe the different factors related to small business capitals, preferences and to suggest the strategic measure for small business owner and share holders. The reviver collects the data by standard reference books, monthly magazines and news papers.

3. Results
In order to discussion, the debt could be secured, unsecured and convertible and nonconvertible, they are issued with a maturity date. But, Equity is important stock used by the firms to raise the fund to finance their activity. As a result, they have residual claims on income and assets of the company. In Debt trust deed or indenture definitions the legal relationship between the issuing company and the debt trustee who represent the holder, the holder have the prior claim on the company's income and assets.

4. Discussion
The capital formation process describes the various means through which capital is transferred from people who save money to businesses that require funds. Such transfers may take place directly, meaning that a business sells its stocks or bonds directly to savers who provide the business with capital in exchange. Transfers of capital may also take place indirectly through an investment banking house or through a financial intermediary, such as a bank, mutual fund, or insurance company. In the case of an indirect transfer using an investment bank, the business sells securities to the bank, which in turn sells them to savers. In other words, the capital simply flows through the investment bank. In the case of an indirect transfer using a

financial intermediary, however, a new form of capital is actually created. The intermediary bank or mutual fund receives capital from savers and issues its own securities in exchange. Then the intermediary uses the capital to purchase stocks or bonds from businesses.

The Cost of Capital

Capital is a necessary factor of production and, like any other factor, it has a cost. In the case of debt capital, the cost is the interest rate that the firm must pay in order to borrow funds (Brigham and Eugene, 1989). For equity capital, the cost is the returns that must be paid to investors in the form of dividends and capital gains. Since the amount of capital available is often limited, it is allocated among various businesses on the basis of price. Firms with the most profitable investment opportunities are willing and able to pay the most for capital, so they tend to attract it away from inefficient firms or from those whose products are not in demand. But the federal government has agencies which help individuals or groups, as stipulated by Congress, to obtain credit on favorable terms. Among those eligible for this kind of assistance are small businesses, certain minorities, and firms willing to build plants in areas with high unemployment (Schilit, 1990)

As a rule, the cost of capital for small businesses tends to be higher than it is for large, established businesses. Given the higher risk involved, both debt and equity providers charge a higher price for their funds. A number of researchers have observed that portfolios of small-firm stocks have earned consistently higher average returns than those of large-firm stocks; this is called the small-firm effect. In reality, it is bad news for the small firm; what the small-firm effect means is that the capital market demands higher returns on stocks of small firms than on otherwise similar stocks of large firms. Therefore, the cost of equity capital is higher for small firms." The cost of capital for a company is a weighted average of the returns that investors expect from the various debt and equity securities issued by the firm (Brealey and Myers, 1991)

Capital Structure

Since capital is expensive for small businesses, it is particularly important for small business owners to determine a target capital structure for their firms. The capital structure concerns the proportion of capital that is obtained through debt and equity. There are tradeoffs involved: using debt capital increases the risk associated with the firm's earnings, which tends to decrease the firm's stock prices. At the same time, however, debt can lead to a higher expected rate of return, which tends to increase a firm's stock price. Because the optimal capital structure is the one that strikes a balance between risk and return and thereby maximizes the price of the stock and simultaneously minimizes the cost of capital (Brigham and Eugene, 1989)

Capital structure decisions depend upon several factors. One is the firm's business risk—the risk pertaining to the line of business in which the company is involved. Firms in risky industries, such as high technology, have lower optimal debt levels than other firms. Another factor in determining capital structure involves a firm's tax position. Since the interest paid on debt is tax deductible, using debt tends to be more advantageous for companies that are subject to a high tax rate and are not able to shelter much of their income from taxation.

A third important factor is a firm's financial flexibility, or its ability to raise

capital under less than ideal conditions. Companies that are able to maintain a strong balance sheet will generally be able to obtain funds under more reasonable terms than other companies during an economic downturn. Brigham recommended that all firms maintain a reserve borrowing capacity to protect themselves for the future. In general, companies that tend to have stable sales levels, assets that make good collateral for loans, and a high growth rate can use debt more heavily than other companies. On the other hand, companies that have conservative management, high profitability, or poor credit ratings may wish to rely on equity capital instead.

Sources of Capital

DEBT CAPITAL Small businesses can obtain debt capital from a number of different sources. These sources can be broken down into two general categories, private and public sources. Private sources of debt financing, include friends and relatives, banks, credit unions, consumer finance companies, commercial finance companies, trade credit, insurance companies, factor companies, and leasing companies (Schilit, 1990). Public sources of debt financing include a number of loan programs provided by the state and federal governments to support small businesses.

There are many types of debt financing available to small businesses—including private placement of bonds, convertible debentures, industrial development bonds, and leveraged buyouts—but by far the most common type of debt financing is a regular loan. Loans can be classified as long-term, short-term, or a credit line. They can be endorsed by co-signers, guaranteed by the government, or secured by collateral—such as real estate, accounts receivable, inventory, savings, life insurance, stocks and bonds, or the item purchased with the loan.

When evaluating a small business for a loan, lenders ideally like to see a two-year operating history, a stable management group, a desirable niche in the industry, a growth in market share, a strong cash flow, and an ability to obtain short-term financing from other sources as a supplement to the loan. Most lenders will require a small business owner to prepare a loan proposal or complete a loan application. The lender will then evaluate the request by considering a variety of factors. For example, the lender will examine the small business's credit rating and look for evidence of its ability to repay the loan, in the form of past earnings or income projections. The lender will also inquire into the amount of equity in the business, as well as whether management has sufficient experience and competence to run the business effectively. Finally, the lender will try to ascertain whether the small business can provide a reasonable amount of collateral to secure the loan.

EQUITY CAPITAL Equity capital for small businesses is also available from a wide variety of sources. Some possible sources of equity financing include the entrepreneur's friends and family, private investors, employees, customers and suppliers, former employers, venture capital firms, investment banking firms, insurance companies, large corporations, and government-backed Small Business Investment Corporations (SBICs).

There are two primary methods that small businesses use to obtain equity financing: the private placement of stock with investors or venture capital firms; and public stock offerings. Private placement is simpler and more common for young

companies or startup firms. Although the private placement of stock still involves compliance with several federal and state securities laws, it does not require formal registration with Securities and Exchange Commission. The main requirements for private placement of stock are that the company cannot advertise the offering and must make the transaction directly with the purchaser.

5. Conclusion

Public stock offerings entail a lengthy and expensive registration process. In fact, the costs associated with a public stock offering can account for more than 20 percent of the amount of capital raised. As a result, public stock offerings are generally a better option for mature companies than for startup firms. Public stock offerings may offer advantages in terms of maintaining control of a small business, however, by spreading ownership over a diverse group of investors rather than concentrating it in the hands of a venture capital firm.

6. References

Brealey RA and Myers SC (1991). Principles of Corporate Finance. 4th ed. New York: *McGraw-Hill*.

Brigham EF (1989). Fundamentals of Financial Management. 5th edition, *Chicago Dryden Press.*

Groth JC and Anderson RC (1997). Capital Structure: Perspectives for Managers. *Management Decision.*

Heaton HB (1998). Valuing Small Businesses. The Cost of Capital. *Appraisal Journal.* 1:16-31

Lindsey J (1986). The Entrepreneur's Guide to Capital. *Chicago Press.*

Ryen GT, Vasconcellos GM, and Kish RJ (1997). Capital Structure Decisions: What Have We Learned?. *Business Horizons.* 40(5): 41-50

Schilit WK (1990). The Entrepreneur's Guide to Preparing a Winning Business Plan and Raising Venture Capital. *Englewood Cliffs, NJ: Prentice Hall.*

Eth.J.Sci & Technol. 5(2): 146-157, 2008 ISSN 1816-3378

Motives for *Labeobarbus* Fish Species Migration to Gumara River, Lake Tana, Ethiopia

Miheret Endalew Tegegnie
Amhara Region Agricultural Research Institute, Bahir Dar Fish and other Aquatic Life Research Center, +251 058 2200899 (off.), Fax: +251 058 2207249. PO Box, 794, Bahir Dar, Ethiopia . E-mail: miheretendalew@yahoo.com

Abstract
The flocks of endemic fish species in Lake Tana, i.e., *Labeobarbus* species (*L. intermiduis, L. tsanansis, L. brevicifaleus, L. acutirostris* and others) migrate for spawning during the rainy season (peak from August to September) to the rivers that flow into Lake Tana. These migrations make them vulnerable for aggregated fishery. The Gumara River is one of the tributaries that flow into Lake Tana where the *Labeobarbus* fish species migration is predominant. A study was conducted to determine the factors that trigger *Labeobarbus* migration to Gumara River from January 2001 to November 2001. The objectives of the study were: to determine the factors that stimulate the migration of the *Labeobarbus* fish species to the Gumara River mouth and upstream and based on that to recommend protective measures. Fish and environmental data were collected at two sites, i.e., at the River mouth and upstream of Gumara. Data were analyzed using simple statistical models. Amount of rainfall and level of the lake appeared to trigger upstream migration of *Labeobarbus*. To protect the breeding population of migrating *Labeobarbus*, fishing must be prohibited from July-October at the river mouths, rivers and their tributaries.

Keywords: *Labeobarbus* species; fish migration; spawning population; environmental factors, management

1. Introduction
Lake Tana, the source of the Blue Nile, is the largest lake in Ethiopia. It covers an area of over 3 thousand km^2 and has an average depth of 8 m, with a maximum of 14 m. It is situated at an altitude of 1830 m and can be characterized as an oligo-mesotrophic lake. The watershed of Lake Tana is about 17 thousand km^2. A major rainy season with heavy rains, during June to October and sometimes a minor rainy season during February to March characterize the climate of Lake Tana and its environs.

The Lake Tana ecosystem provides multiples of services. Electric power generation, water transportation, irrigation agriculture, sand mining, water for consumption, waste disposal, fisheries, ecotourism are a few of the services. The information on these activities is in scarce. Scientific information on the species composition, abundance, distribution and dynamics of the fish stocks in Lake Tana is not adequate.

Gilgel Abay, Rib, Gumara, Gelda, and others enter the lake, the Blue Nile River being the only outflow. Some 30 km downstream, the Blue Nile river plunges down 40-meter-high waterfalls, isolating Lake Tana and its tributaries from other Parts of the Nile basin. Four fish species dominate the commercial and traditional fishery. Tilapia (*Oreochromis niloticus*), Catfish (*Clarias gariepinus*), the various morpho-type *Labeobarbus* species flock (*L. intermiduis, L. tsanansis, L. brevicifaleus, L. acutirostris*) and other *Labeobarbus* fish species flock (Nagelkerke, 1997) and to some extent *Varicorhinus beso*. Small barbus fish is a key species in the Lake Tana food web, supporting that the most important flow of energy and mass to the *Labeobarbus* biomass production that leads from phytoplankton via zooplankton (Dejen et al., 2004).

The cyprinids are the major component of the fish fauna. The *Labeobarbus* fish species have migration behavior for reproduction. Recent studies revealed that the different species of *Labeobarbus* fish species migrate at different times and space (Nagelkerke, 1997; de Graaf, 2003; Wassie, 2005). Gumara River was identified as a major breeding ground of *Labeobarbus* fish species. The unique *Labeobarbus* fish species that are only found in Lake Tana are currently under high fishing pressure unlike other non-migrating species *Oreochromis niloticus* and *Clarias garipinus*.

The main problem of the high fishing pressure on the *Labeobarbus* fish species is related to migration into the inflowing river Gumara and its tributaries for reproduction. The intensity of fishing pressure on the *Labeobarbus* fish species on Gumara River is high because of the *open access* or unregulated situation. The fishing community use traditional fishing techniques such as poisoning fish by using powdered Birbira, *Milletia ferruginea* (Abebe Ameha, 2004). Recently, researchers suggested the need for working on the biology and management of fish stocks (Nagelkerke, 1997; Tesfaye Wudneh, 1998; de Graaf 2003; Dejen et al., 2004). Generally development of commercial fishery has been intensified over the last decade in Lake Tana (Tesfaye Wudneh, 1998).

To promote Sustainable spawning Stock Biomass (SSB) of the *Labeobarbus* fish species and to develop appropriate management strategy/tool, information is required on where, when and why the *Labeobarbus* fish species migrate. De Graaf (2003) has addressed the where and when issue of the migration. However, specific factors that trigger spawning migration are not clearly identified. Thus, the objectives of this research paper were to identify what environmental factors trigger upstream migration of *Labeobarbus* fish species and then to recommend some management techniques so that the Sustainable Spawning Biomass (SSB) of the *Labeobarbus* fishes species will be protected.

2. Materials and Methods

Study Area

The Gumara River is one of the tributaries that flow into Lake Tana. A number of small streams/rivers feed the Gumara River. The tributaries contribute water and enrich the ecology of the Gumara River. In the upstream, near *Wanzaye hot spring*, a natural waterfall hinders the upstream movement of fish. The water volume of Gumara significantly fluctuates with season (high during the rainy season and low during dry season). The riparian system also varies. The upstream is covered with natural shrubs; the lower stream is devoid of the natural vegetation because of heavy agricultural activities. Fig. 1 shows the traditional fishing practiced by farmers, which is typically unregulated. The sampling site is illustrated in Fig. 2.

Data Collection and analysis

Fish data was collected monthly from January 2001 to June 2001 (dry season) and from July 2001 to November 2001 (wet season) from the River mouth (*Megenagna*) and upstream of Gumara (*Wanzaye hot spring*) for about one year. The data collection continued for the whole year at the Gumara River mouth (*Megenagna*) and was interrupted during the wet season at the *Wanzaye* upstream because of difficulty of fishing with gillnets on the river.

Fig. 1. Open access fishing on migrating Labeobarbus fish species at Gumara River; Source: Amhara Region Bureau of Agriculture and Rural Development, Bahir Dar, Ethiopia**.**

For few occasions fish data were collected on tributaries (*Kizen* and *Dokalit*). Sampled fish were categorized in terms of species, sex, gonad maturity stage, body length and weight. The monthly average rainfall (1995 - 2004) and average monthly daily air temperature (1999-2003), data was purchased from the Ethiopian Meteorology Services Agency. The Lake Tana water level data was collected from the Bureau of the Amhara National Regional State Water Resources Development. Limnological data such as water temperatures, pH and oxygen were collected throughout the data collection period at the two sites. Different mesh size of gillnets (40 mm, 60 mm, 80 mm, 100 mm, 120 mm and 140 mm) were used to collect fish. Measuring boards and balances were also used in data collection. A pH meter, model 3050 ELE, Electric Products (China) and oxygen meter, Oxy guard International A/S (Denmark) were used to measure the limnological parameters. At Megenagna site, water level change of the lake was observed on monthly basis. The Gumara River water flow was also observed during the data collection period. Descriptive statistics was used for data analysis.

Fig. 2. Map of Ethiopia, Lake Tana and Gumara River; **Source**: Bahir Dar Fish and Aquatic Life Research Center

3. Results

Environmental Parameters

Environmental parameters are shown in Figs. 3, 4, 5 and 6. Having a look at a four year data (1999-2003), the average daily air temperature in the sampling site at Gumara River mouth (*Megenagna*) peaked in April to May (dry season) and at the end of the wet season including the sampling year 2001 (Fig. 3). The average monthly rainfall of Lake Tana was higher from June to August in the sampling period.

The water temperatures showed two peaks at the Gumara River mouth. The first peak occurred during dry season in May and the second peak occurred in November at the end of wet season (Fig. 5). The pH and oxygen data did not show significant variation during the sampling period. The water level of Lake Tana increased at the end of the wet season (August to November) (Fig. 6). The water level increased because of the influx of water from the different inflowing rivers one of which is the Gumara River.

Fish Abundance and Species Composition

A total of 2567 fish was sampled during the study period. The sample consists of 89% *Labeobarbus* fish species and 11% non-labeobarbus fish species in both sampling sites. The total number of sampled fish, the *Labeobarbus* and non-Labeobarbus species composition during the wet season is higher than the number caught during the dry season. A total of 2013 fish were sampled at the Gumara River mouth and 554 at Wanzaye upstream. At the Gumara River mouth, some 63.1% of the fish were sampled during the wet season and 36.9% during the dry season.

At Megenagna sampling site, 75.6% of the fish sampled belonged to the dominant Labeobarbus fish species comprising 52.6% *L. intermiduis*, 9% *L. tsanansis*, 7% *L. brevicifaleus*, 7% L. acutirostris and 13.4% other Labeobarbus fish species (Table 1). *L. intermiduis* and *L. tsanansis* were the dominant species. At Wanzaye, no sampling was conducted because of difficulty of net setting in the river during the wet season. Some fish were collected from a few tributary rivers (Table 2). Labeobarbus species were also more abundant and had more species composition during the wet season (Table 2).

4. Discussion

The Environmental Parameters

Having a look at a four year data (1999-2003), the average daily air temperature in the sampling site at Gumara River mouth (*Megenagna*) peaked in April to May (dry season) and at the end of the wet season including the sampling year 2001 (Fig. 3). The average monthly rainfall of Lake Tana was higher from June to August in the sampling period. This corroborates data for the longer term period (1995 - 2004) confirming the rainfall for the above stated months (Fig. 4). The water volume increment of both the Gumara river and Lake Tana increases vertically and longitudinally during the rainy season facilitating the migration of the *Labeobarbus* fish species to the river mouth and upstream.

Table 1. Fish Species Sampled at Gumara River Mouth (Megenagna) from January 2001 to November 2001

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
B. acutirostris	25	4	16	2	12	3	4	3	11	14	25	
B. brevicephalis	20	0	0	0	18	4	3	10	5	15	20	
B. dainellii	5	0	0	7	0	2	0		0	0	0	
B. intermidius	30	58	150	25	26	54	83	76	104	180	284	
B. tsanensis	1	0	49	0	5	0	25	19	47	66	7	
B. truttiformis	1	6	2	8	2	1	1	1	6	7	0	
B. platydorusus	0	0	0	0	0	0	2	1	5	6	6	
B. crassibarbus	0	0	0	0	0	0	3	3	6	9	2	
B. megastoma	0	0	0	0	0	0	1	1	3	4	0	
B. macrophtalmus	0	0	0	0	0	0	0	0	6	6	6	
V. beso	0	0	0	8	0	6	0	0	1	0	1	
C. gariepinus	32	4	28	29	8	0	1	8	1	9	1	
O. niloticus	41	9	36	1	6	0	2	0	0	0	1	
Total # species	8	5	6	6	7	6	10	9	11	10	10	
Total # fish	153	81	81	80	77	70	125	122	195	317	512	

Table 2. Fish Species Sampled at Gumara Upstream (Wanzaye) from January 2001 to November 2001

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
L. acutirostris	2	6	1	-	22	4	11	7	3	-	1	-
L. brevicephalis	5	4	4	-	15	6	1	.-	7	-	39	-
L. dainellii	3	2	.-	-	.-	2	-	.-	. .-	-	.-	-
L. intermidius	10	50	8	-	18	8	32	6	62	-	29	-
L. tsanensis	1	5		-	-	4	-	-	-	-	.-	-
L. truttiformis	-	-	3	-	-	-	-	-	-	-	6	-
L. platydorusus	-	-	-	-	-	-	-	-	-	4	-	-
L. crassibarbus	-	-	-	-	-	-	-	-	-	-	-	-
L. megastoma	-	-	-	-	-	-	-	1	8	1	8	-
L. macrophtalmus		-	-	-	-	-	-	-	-	-	-	.-
V. beso	2	-	4	8	6	-	-	-	-	-	-	-
C. gariepinus	-	-	-	10	9	-	-	-	-	-	-	-
O. niloticus	-	9	-	-	2	-	-	-	-	-	-	-

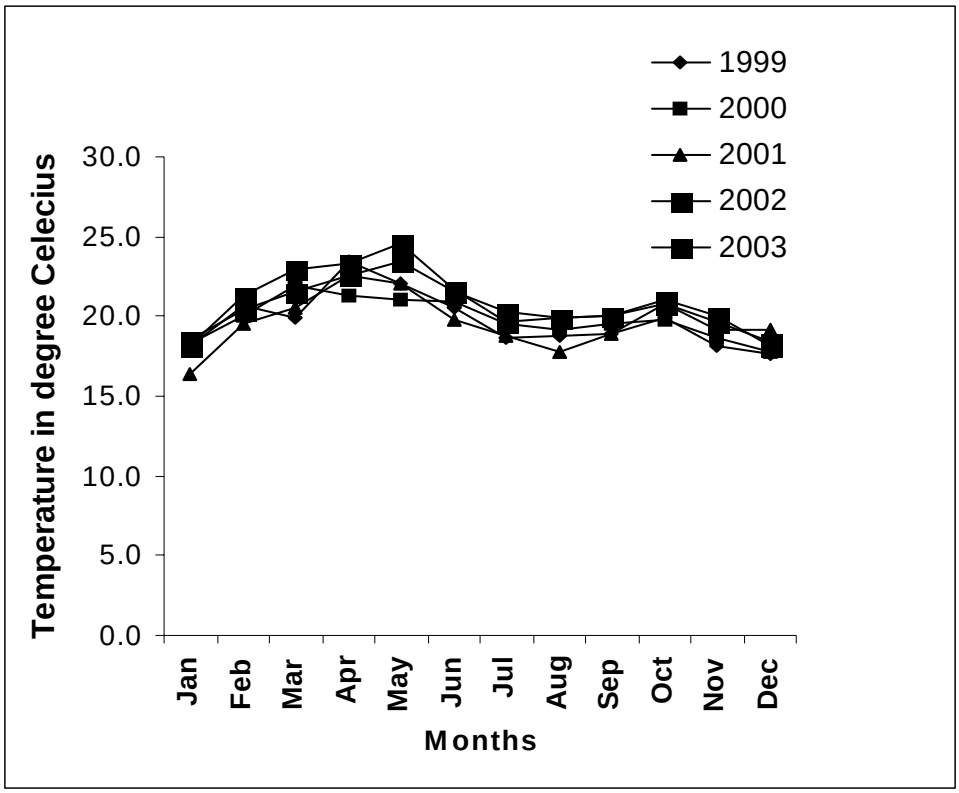

Fig. 3. Average daily air temperature of Lake Tana from 1999 to 2003.

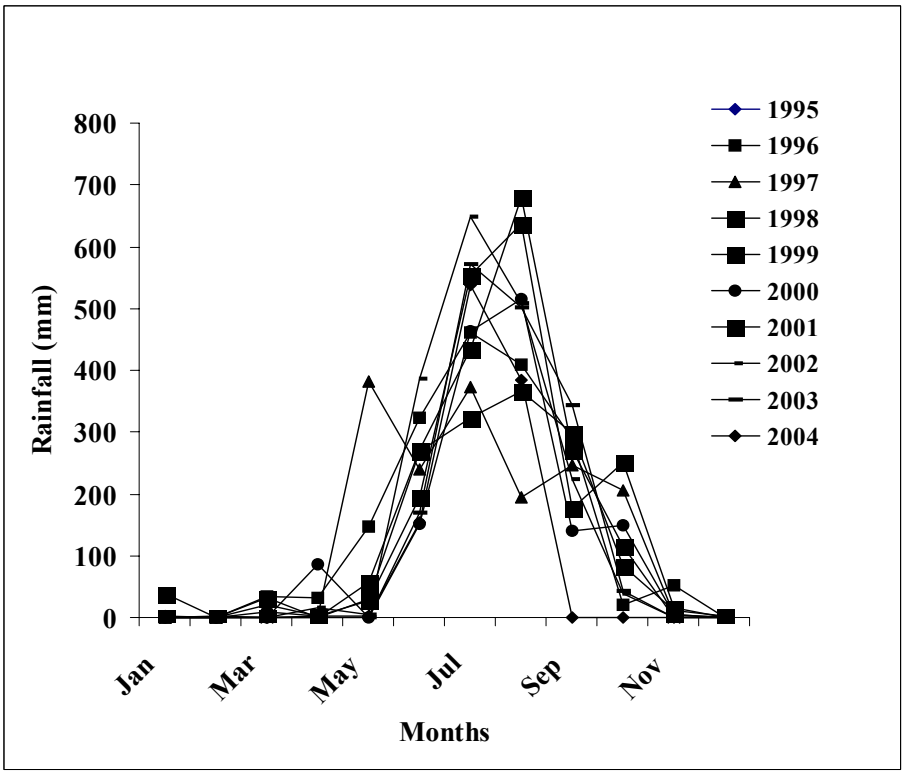

Fig. 4. Average Monthly Rainfall on Lake Tana from 1995 - 2004.

The water level always peaked in September to October as confirmed from the previous (Fig. 6) and observed during the study period (personal observation). The rainfall facilitates stimulating factors such as increment of longitudinal water volume connectivity of the Gumara River creating suitable and favorable condition such as pool and rifle water current that facilitate migration and spawning.

As indicated in the result the seasonal increment of *Labeobarbus* fish migration in terms of species and total number indicates that wet season environmental parameters particularly rainfall and water level have triggering mechanism for upstream migrations of the *Labeobarbus* fish species. The wet season rainfall associated factors externally influenced by influx of water from the tributary rivers creating pool and rifle condition in Gumara and nutrients that could be stimulant to the migration of the spawning population of the *Labeobarbus* fish species are considered to be the important factor that could have played great role in stimulating the migration. This does not rule out further investigation on other environmental and physiological factors that could have the triggery mechanism for spawning migration of *Labeobarbus* fish species of Lake Tana. The other environmental factors of Lake Tana considered and observed during the sampling period are almost similar as stated by previous studies (Tesfay Wudneh, 1998; de Graaf et al., 2003; Dejen et al., 2004).

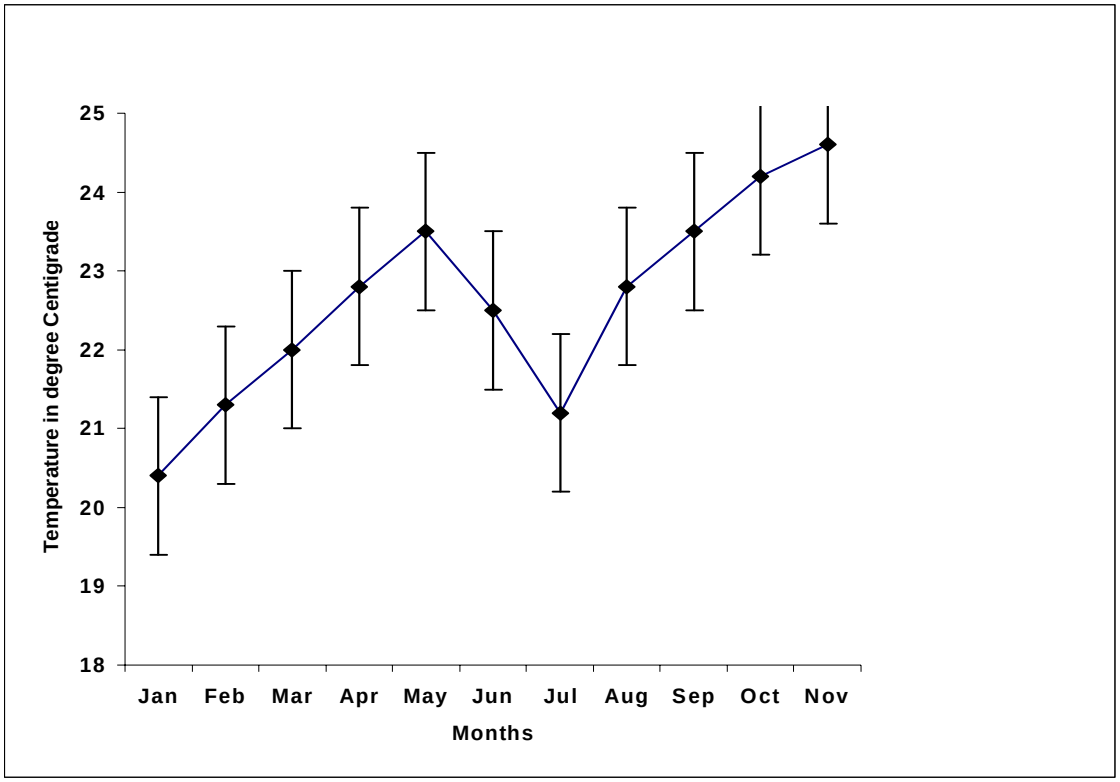

Fig. 5. Monthly Water Temperature at Gumara River Mouth (Megenagna) from January 2001 to November 2001

De Graaf et al. (2003) stated that most migratory fish species in the inter-tropical regions including African Barbus at large make their upstream migration during the rainy season accompanied with high flow of water. Banks (1969) also stated that an increase in river flows stimulates Atlantic salmon to enter fresh water. River flow is the variable most frequently mentioned as controlling the rate of upstream migration of Atlantic salmon (Banks, 1969; Alabaster, 1970). It is generally assumed that increases in river flow stimulate Atlantic salmon to ascend a river (Jensen et al., 1986; Laughton, 1991).

The present study of Lake Tana *Labeobarbus* fish species migration towards the Gumara River mouth and upstream of Gumara River with water flow increment associated with rainfall as stimulating factor for migration has a conformity with previous studies that have been done by different authors in different parts of the world.

Fish Abundance and Species Composition

The seasonal variation of the *Labeobarbus* fish species aggregation in number and species composition during the sampling period in the Gumara River mouth and upstream migration indicated the coherence with the influx of nutrients and other rainfall associated factors during the wet season within Gumara River and its tributary rivers.

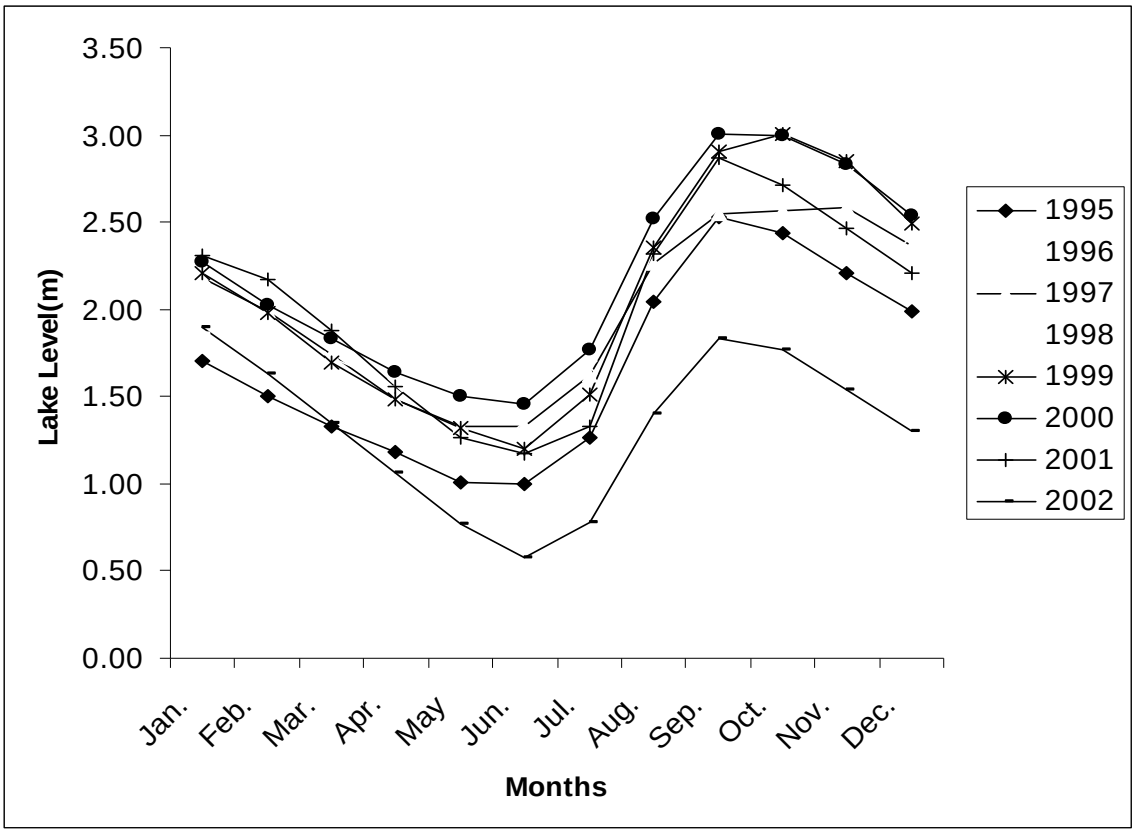

Fig. 6. Lake Tana water level from 1995 – 2002

These results indicated that *Labeobarbus* fish species migration during the wet season for reproduction exposes for fishing pressure at their way and requires protection through well established management strategy that enable to take measures that sustain the biodiversity of the Lake Tana and its surroundings.

De Graaf et al. (2004) stated that the Catch per Unit Effort of Labeobarbus fish species in July to October is three times higher in the river mouth of Gumara when compared with the mean Catch per Unit Effort of the lake on other occasions. This confirms that the abundance of migrating of *Labeobarbus* fish species is associated with the wet season particularly associated with rainfall and lake and river water level increment. The use of motorized commercial gillnet fisheries targeting the spawning aggregations in the Gumara River mouth and other inflowing rivers seems to be the main cause of observed dramatic decline of Lake Tana's Labeobarbus fish species stock (de Graaf et al., 2003).

To mitigate this declining situation of the migrating *Labeobarbus* fish species, the Lake Tana fisheries resource calls for Appropriate Management Plan for the targeted *Labeobarbus* fish species in particular and for the fisheries resources of the lake in general. The Appropriate Management Plan objective of fisheries management of Lake Tana must ensure the sustainable use of Lake Tana fisheries resources by the fisheries communities of the Lake. Four basic ideas to be considered in fisheries resource management and development of Lake Tana include:

i. The management of the fisheries resource of Lake Tana should incorporate social and political considerations.
ii. The management strategies and tools used efficiently from the fishery's biology point of view should be socially and politically accepted to the parties involved in fisheries particularly whose livelihood is affected by the management implementation.
iii. The stated reference points (Maximum Sustainable Yield/MSY) for the management of the fisheries of Lake Tana or targets to be achieved should not be reached.
iv. The control mechanism (closed area and closed season) is effective to sustain the fisheries resources in terms of cost, beneficiaries, with clearly defined procedures and responsibilities of all parties involved.

These basic concepts are considered as the springboard for fisheries resources management of Lake Tana *Labeobarbus* fish species that is considered as declining species. Appropriate management strategies/tools that can be applied on Lake Tana fisheries resources could be many but the urgent situation calls to implement the closed area and closed season management strategies/tools to sustain fisheries of Lake Tana, particularly for *Labeobarbus* fish species that are at potential risk of declining.

5. Conclusion and recommendation

The fishers community harvest *Labeobarbus* fish species on Gumara River mouth and upstream spawning grounds using a variety of fishing techniques such as gillnetting, barriers / fences, basket traps, hooks, scoop nets and poisoning with dried and crushed seeds of birbira tree (*Milletia ferruginae, Leguminosae*).

The research data showed that the Lake Tana *Labeobarbus* fish species in Gumara River mouth and upstream spawn during high flow of water volume consistent with other inter-tropical species. Workable management strategies that limit the motorized gillnet fishery at all feeder streams of the lake during and at the conclusion of the rainy season is vital. Considering Gumara River as an aquatic park may also be justified to maintain the appropriate spawning biomass. A vigorous public education campaign is essential for conveying the need to preserve the *Labeobarbus* fish species for the present and the next generations. To mitigate and ameliorate the open access system, of fisheries during the wet season, the Federal Democratic Republic of Ethiopia (2003) Proclamation No 315/2003 and Amhara National Regional State (2003) Proclamation No. 92/2003 of Fisheries Legislation at Federal and Regional levels have to be implemented before the resources become depleted resulting in inefficient biological, economic and social effect in the long-term situation of the fisheries resource in particular and the biodiversity in general.

6. Acknowledgements

I would like to thank the Ethiopian Science and Technology Commission for the local research grants, Amhara Regional Agricultural Research Institute /ARARI and Bahir Dar Fish and Other Aquatic Life Research Center /BFALRC facilitating the research project. I forward my thanks to the Ethiopian Meteorology Services Agency for they provided me monthly average rainfall and air temperature data, and the Amhara National Regional State Water Resources Development Bureau for Lake Tana water level data. I thank the different individuals in the research center and in other institutions who contributed in data collection.

7. References

Abebe Ameha (2004). The effect of Birbira, *Milletia ferrugnea* (Hochst.) Baker on some *Barbus* spp. (Cyprinidae, Teleostei) in Gumara River (Lake Tana), Ethiopia. M.Sc. Thesis, Addis Ababa University, School of Graduate Studies. 57pp

Alabaster JS (1970). River flow and upstream movement and catch of migratory salmonids. *Journal of Fish Biology.* 1:1-13.

Amhara National Regional State (2003). Fisheries Development, Prevention and Utilization, Proclamation No 92/2003, Zikre Hig, 9th Year, No. 3, 17th December, Bahir Dar. pp. 12

Banks JW (1969). A review of the literature on the upstream migration of adult salmonids. *Journal of Fish Biology* 2: 85-136.

De Graaf M, Machiels MAM, Wudneh T, Sibbing FA (2003). Length at maturity and gillnet selectivity of Lake Tana's Barbus species (Ethiopia): implication for management and conservation. *Aquatic Ecosystem Health and Management 6*(3):325-336

De Graaf M, Machiels MAM, Wudneh T, Sibbing FA (2004). Declining stocks of Lake Tana's endemic Barbus species flock (Ethiopia): natural variation or human impact? *Biological conservation* 116: 277-287.

Dejen E, Vijverberg J, Nagelkerke LAJ and Sibbing FA (2004). Temporal and spatial distribution of microcrustacean Zooplankton in relation to turbidity and other environmental factors in a large tropical lake (Lake Tana, Ethiopia). *Hydrobiologia* 513: 39-49

Federal Democratic Republic of Ethiopia (2003). Fisheries Development and Utilization Proclamation No 315/2003, Federal Negarit Gazeta, 9th Year, No. 32, 4th February, Addis Ababa. pp. 2084

Jensen AJ, Heggberget TG and Johnsen LO (1986). Upstream migration of adult Atlantic salmon, *Salmo salar* L., in the river vefsna, northern Norway. *Journal of Fish Biology* 29: 459-465.

Laughton R (1991). The movements of adult Atlantic salmon *Salmo salar* L., in the River Spey as determined by radio telemetry during

1988 and 1989. *Scottish Fisheries Report* 50. 35pp

Nagelkerke, LAJ (1997). The barbs of Lake Tana ,Ethiopia: Morphological diversity and is implications for taxonomy , tropic resource partitioning , and fisheries. Ph.D.Thesis, Wageningen Agricultural University, The Netherlands. 296pp.

Tesfay Wudneh (1998). Biology and Management of fish stocks in Bahir Dar Gulf, Lake Tana, Ethiopia. PhD Thesis, Wageningen Agricultural University, Wageningen, the Netherlands. 144pp

Wassie Anteneh (2005). Spawning migration and Reproductive biology of labeobarbus (cyprinidae: teleostei) of Lake Tana to Dirma and Megech Rivers, Ethiopia. M.Sc. Thesis, Addis Ababa University, School of Graduate Studies. 95pp

GUIDE TO AUTHORS

AIM: The Ethiopian Journal of Science and Technology (Eth. J. Sci. & Technol.) aims to disseminate scientific and technological information to the public, nationally and internationally.

SCOPE: Eth. J. Sci. & Technol. publishes original, full-length research articles, feature articles, short communications, and review articles in sciences and technology.

FORMAT: Manuscripts should be written in the following layout:
Title Page, Abstract, Introduction, Materials and Methods, Results (Combined results and Discussion is acceptable), Discussion, Conclusion, Recommendation (when necessary), Acknowledgments, and References.

NATURE OF FULL-LENGTH RESEARCH ARTICLES

1. Manuscripts should be written in English or Amharic.

2. Manuscripts should not exceed 20 pages, including the abstract. However, the Editorial Committee may accept longer papers if deemed necessary. Papers should be written in Times New Roman, 12 font size and double spaced between the lines.

3. Two copies of original manuscript (plus a soft copy) printed double-spaced throughout and with wide margins on good quality paper should be submitted.

4. Statement of authorship should be submitted with the manuscript. This should state that:
   - All the authors have agreed to its submission and are responsible for its contents. All authors should preferably sign this statement.
   - The paper, other than an abstract or an oral presentation, has not been or will not be submitted elsewhere.

5. The different sections of manuscripts should look like the following:
   a) Title page, includes the following:
      - A full title of the manuscript.
      - The name(s) and address(es) of the author(s), and Institution(s) in which the research was carried out or similar affiliation(s) of the author(s). The author to whom all correspondence should be addressed has to be indicated.

   b) The Abstract should be informative and completely self-explanatory. Briefly present the topic, state the scope of the experiments and point out major findings and conclusions. It should be between 100 to 300 words in length

   c) Following the abstract, about 3 to 10 key words could be listed.

   d) The Introduction should provide a clear statement of the problem, the relevant literature on the subject, and the objectives of the work (all together in one section). It should be understandable to colleagues from a broad range of scientific disciplines.

   e) Materials and methods should be complete and sufficient enough to allow experiments to be reproduced. However, only truly new procedures should be described in detail; previously

published procedures should be cited, and important modifications of published procedures should be mentioned briefly.

f) Results should be presented clearly and precisely. The results should be written in the past tense when describing findings in the authors' experiments. They should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the Results but should be presented in the discussion section.

g) The discussion should interpret the findings in view of the results obtained in this and/or in past studies on this topic. State the conclusions in a few sentences at the end of the paper. However, a separate conclusion is also applicable. The Results and Discussion sections, when appropriate, could be combined.

h) Brief acknowledgments of people, grants, funds, etc may be provided.

i) Tables should be kept to the minimum (both in size and number) and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, including headings and footnotes. Each table should be numbered consecutively in Arabic numerals and supplied with legend on a separate sheet. The horizontal row wise lines of the table should be deleted except for column headings. Authors are advised to look at recent publications of this journal.

j) Figures and legends should be typed in numerical order on a separate sheet. Use Arabic numerals to designate figures. Information given in legends should not be repeated in the text.

k) Citation and References: All referred materials should be acknowledged. In the text, a reference identified by means of an author's name should be followed by the date of the reference in parentheses. When there are more than two authors, only the first author's name should be mentioned, followed by 'et al.'. In the event that an author cited has had two or more works published during the same year, the reference, both in the text and in the reference list, should be identified by a lower case letter like 'a' and 'b' after the date to distinguish the works. Ethiopian names should be presented as are written in Amharic (and with two names).

   a. Examples of citations in the text:
      - Each reference should have the following form in the text:
        - Two authors: Alexander and Levis (2003) stated that …
        - More than two authors: Alexander et al. (2003) reported that …
      - Put dates of publication chronologically when references are more than one:
        - The current findings corroborate previous reports (Robertson and Charles, 1992; Flint, 1997; Alemayehu Belay et al., 2001).
      - Ethiopian names should be in direct order, i.e., the full first name followed by the father's name: (Amare Belay et al., 1990) and not Belay A.

   b. Examples of references in the reference section. References in the reference section should be written as follows:

Berhanu Abraha and Berhanu A. Gashe (1992). Cellulase Production and Activity in a Species of *Cladosporium*. *World Journal of Microbiology and Biotechnology*. 8:164 -166.

Ogunseitan OA (1998). Protein method for investigating mercuric reductase gene expression in

aquatic environments. *Appl. Environ. Microbiol*. 64: 695–702.

Gueye M, Ndoye I, Dianda M, Danso SKA, Dreyfus B (1997). Active N_2 fixation in several *Faidherbia albida* provenances. *Ar. Soil Res. Rehabil.* 11:63-70.

Charnley AK (1992). Mechanisms of fungal pathogenesis in insects with particular reference to locusts. In: Lomer CJ, Prior C (eds.). *Biological Controls of Locusts and Grasshoppers*: *Proceedings of an international workshop held at Cotonou*, Benin. Oxford: CAB International, pp 181-190.

FAO (Food and Agriculture Organization) (1998). Food Security in Ethiopia: FAO technical report NO. 65. Rome, Italy.

Arrange the references alphabetically from A to Z.

OTHER COLUMNS

Review Articles

These are aimed at giving an overview of a particular subject suitable for a wider audience that includes recent advances in an area in which an author has been actively engaged.

Short Communications

Short communications must report completed work, not preliminary findings. They are an alternative format for describing smaller pieces of work. They should not be more than eight pages and should not contain more than two figures, tables or combinations.

Feature Articles

These are articles that may cover a range of topics in basic and applied sciences, technology, and related fields.

Note: Please see recently published papers in Eth. J. Sci. & Technol. for references not mentioned in this guide.

SUBMISSION OF MANUSCRIPTS

Electronic copies of manuscripts should be sent to:
The Editor,
Ethiopian Journal of Science and Technology,
The Research and Community Services,
Bahir Dar University,
PO Box 79, Bahir Dar, Ethiopia.
Tel: +251 058 220 5926
E-mail: ejstbdu@gmail.com, melakuwale@gmail.com