

# Ultra-centrifuge structure and its application in food industry

Mohammadyar Hosseini<sup>1</sup>, Saman AziziZadeh<sup>2</sup>

1: Department of food science and technology, Ilam University

2: Master of Science student of Urmia University

**Abstract**— This article including of theoretical summary of ultra-centrifuge structure and its application in food industry. Ultra-centrifuges are equipped with one or two light detector systems for considering separation components. A few applications of ultra-centrifuge include examination of sample purity, molecular weight, analysis of associating systems and so on. In this article, use of ultra-centrifuge at food studies has been investigated that includes detection of microbial toxins, study of fat oxidation during storage, detection of virus and so on.

**Keywords**—ultra-centrifuge, detector, separation

## I. INTRODUCTION

Centrifuge is a technology that separates two or more parts with different sizes or different density e.g. macromolecules dissolved at one solvent or suspended particles at a dispersion. There is not a threshold that determines ultra-centrifuge limit but often centrifuges that generates power 5000 times more than gravity acceleration of earth is called ultra-centrifuge and is classified to preparative and analytical type.

## II. DEFINITION OF ULTRA-CENTRIFUGE

Ultra-centrifuges are centrifuges that are equipped with one or two light detector systems that researcher can observe way of separation components by detector during centrifuge process.

## III. HISTORY OF ULTRA-CENTRIFUGE

This apparatus was invented by a Sweden chemist named Sudberg in 1924. This chemist used it to examine nanoparticle and measure size gold particles with 2 nanometers in diameter. He was rewarded noble chemistry in 1926. After a few years, he developed it to biochemistry area and as the first researcher using this method, he measured molecular weight of biopolymers especially proteins. Dissociative ultra-centrifuge is generally a powerful method for analysis of polymer properties, biopolymers polyelectrolytes, nanoparticles, dispersions, emulsions and other colloid systems. This is a good method to examine molecular weight, size of particles, particle density and examination of reaction coefficients.

Since, it is a separation process, determination of molar weight distribution, distribution of particle size and its density are provided by it.

## IV. GENERAL USE OF ULTRA-CENTRIFUGE

### A. Examination of sample purity

The basis of examination of available sample purity at solution by ultra-centrifuge is related to sedimentation velocity during centrifuge. This method is used as a fast and powerful way for determination of purity and since samples were evaluated at pure and specific solution and solvent, thus it is used for examination of structure and also association degree and aggregation of macromolecules.

### B. Determination of macromolecules weight

Dissociative ultra-centrifuge is a method that is used for direct measurement of molecular weight of material at natural state and solution at solvent. One of advantages of this method is that calibration is not required and is not a complex and time-consuming method. It measures molecular weight from a few hundred (e.g. sucrose) to a few million (e.g. viral parts) and there is not any other method that is able to measure molecular weight at this expanded area of molecular weight. This is used for determination of molecular weight of proteins, nucleic acid and carbohydrates. In fact, this technique is able to determine molecular weight of materials that have different light absorption or light refraction from solvent. One of the advantages of this method is that it needs samples with little quantity (20-120 microliter) and low viscosity (0.1-1 g/liter). However, methods such as light dispersion, smometry and use of x-rays are ways to study molecular weight, but none of them are able to examine it at wide range. Also, they require more quantity of sample for examination. Methods such as electrophoresis and chromatography have not the scientific basis and use of them requiring to accept a series of hypothesis.

## V. ANALYSIS OF ASSOCIATING SYSTEMS

Use of analysis of sedimentation by ultra-centrifuge is a valuable way at study of changes at molecular weight during

associating of molecules and generating more complex structures. Much of biological activities are depended on reaction between its macromolecules. The electrophoresis method containing SDS, give us information about their components and stoichiometry but this method with ultra-centrifuge can show molecular weight of complex component when are in the solution without depending on their shapes. Macromolecules have multi associating state and use of ultra-centrifuge with sedimentation velocity can distinguish types of associating states. Use of analysis of sedimentation can evaluate molecular weight of components separately that have participated in complex. Also, size of complex, stoichiometry and power links between units forming complexes is measurable.

#### VI. EXAMINATION OF COEFFICIENT OF SEDIMENTATION AND PENETRATION AND DISTINGUISHING OF CONFORMATION CHANGES

Nowadays, use of x-ray and NMR technique are only methods that are used for determination of structure details at atom dimension. Therefore, determination of general size and shape of macromolecules or complexes at solution requires measuring degree of replacement these particles at solution. The test of measurement of sedimentation velocity that was performed by ultra-centrifuge was allowed to examine coefficients of sedimentation and penetration that indicating size and shape of macromolecules and their reactions. Specially, sedimentation coefficient is used to determinate conformation changes generated at proteins and nucleic acids. Also, bending degree of nucleic acids is determinable by measuring of sedimentation quantity. Some of enzymes have a few oligomer states and all of these oligomers have not enzyme activity. Using of ultra-centrifuge by light absorption techniques and chromogenic substrates can determine degree activity of these different enzyme oligomer states. This state is possible by determining of sedimentation behavior of enzymes at much diluted phase (not pure phase).

#### VII. PARTS OF ULTRA-CENTRIFUGE MACHINE

The basis of dissociative ultra-centrifuge includes of fast rotation of a rotator with precise and controllable velocity at a container that temperature is precisely controlled. Viscosity distribution at this machine is registered at the certain intervals. The ability of measurement and registration of this procedure during rotation of rotor at dissociative ultra-centrifuge is considered as an indicator for distinguishing of this method from preparative ultra-centrifuge. At this system, for access to high sedimentation velocity and decrease of distribution degree, using of high angel velocities is very necessary. Rotor of dissociative ultra-centrifuge is able to rotate with velocities above to 60000 rpm. To prevent of increasing temperature resulting from friction and decreasing aerodynamic vibrations, rotor is rotated at a container under relative vacuum. Figure of ultra-centrifuge made by Beckman Company is shown here.

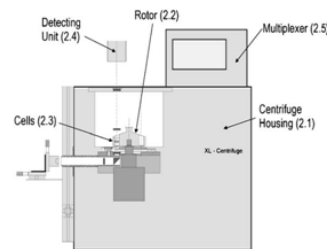


Fig 1. Schematic picture of analytical ultracentrifuge and its most important components

Mainly, today two types of dissociative ultra-centrifuge are used at scientific experiments. Ultra-centrifuges made by Beckman Company are commercially available. Ultra-centrifuges are originally preparative type and are inverted to dispersion type by optimization users. Today, the most successful type of ultra-centrifuges is centrifuges that were made and designed by Beckman Company and the most famous model is optima XL.A. This model has the first grade due to number of application and their expansiveness and is equipped to UV detector. Dissociative ultra-centrifuge systems have main parts as follows:

#### *Rotors*

Rotors are one of main part of centrifuge and due to their high sensitivity; design of this part is very time-consuming. Previously, these parts were made from metals such as steel and aluminum but nowadays only Titanium is used. Note that rotor must be product of a uniform piece of titanium, if not rotors will be broken up due to high stress and pressure at too many rounds of rotors. At high rounds of rotors, the imposed pressure for cell measuring is 25000g that under this pressure, every 1 g of material has 250 kg equivalent weight. Other important issue here is that rotor must not have even little vibration because lack of stability and vibration during rotor work result in increasing amortization and oscillation of measuring cells that consequently increase error in the experiment specially when viscosity and its slope is little. In according to rotor type, four or eight pits are made on titanium rotor. One of pits is full of reference cell. This part is used to radius calibration and regulating speed of centrifuge. Other pits are full by sample cells. Maximum speed and allowed round of every rotor are very important. Rotors that are commercially applicable have 50000 or 60000 round at minute speed. Life expectancy of used rotors at analytic centrifuge is depended on time that they work at its maximum speed. If these rotors do not work at speed higher than 95% of its maximum allowed speed, it is said that they have unlimited life. Following figure presents a rotor with maximum round of 50000 rounds at minute.



Fig 2. Eight- hole analytical rotor made of titanium by Beckman- Coulter

### Measuring cells

Measuring cells are part of ultra-centrifuge that directly is connected with samples of measuring subject. Cells have a few parts that these parts must have working and resistance ability at too high mechanical stresses. This part of ultra-centrifuge at least has two following properties:

1. This cells must not deform at high speed of centrifuge, since speed of pressure maximum equivalent 250 bar is inflicted these cells.

2. These cells must allow light passed through windows that are in quartz or ruby during rotation of rotor.

Different types of centrifuge-cells were made in according to type of experiment that performed and are available. The main difference of these cells is referred to type of center piece and windows. Due to high pressures imposed to cells

during centrifuging, the glass part of cells is made of resistant and transparent material such as quartz and ruby. One of advantages of quartz as compared with ruby is its lower price. Another advantage of quartz is that it allows light pass to developed area when is used of waves with UV amplitude. Center piece is heart of a measuring cell that is made of Aluminum, Titanium and Teflon. Originally, 4 types of central pieces are used for dissociative ultra-centrifuges:

a) One-section center piece that only the sample solution is placed on it. This kind specially was used to Schlieren and turbidity detectors.

b) Two-section center piece that have two separate containers. At the one of them is placed solution of sample and another section is placed pure solvent. This kind was used with types of systems or detectors.

c) Multi-canal type that is used for experiment to three or five different samples with distinct structures. Originally, this group has the same structures with prior groups.

d) Synthetic boundary types: This group has two different kinds: a) capillary b) valve that both of them are designed to allow boundary between sample solution and solvent during rotation of rotor. Following figure shows different parts of a center piece in detail.

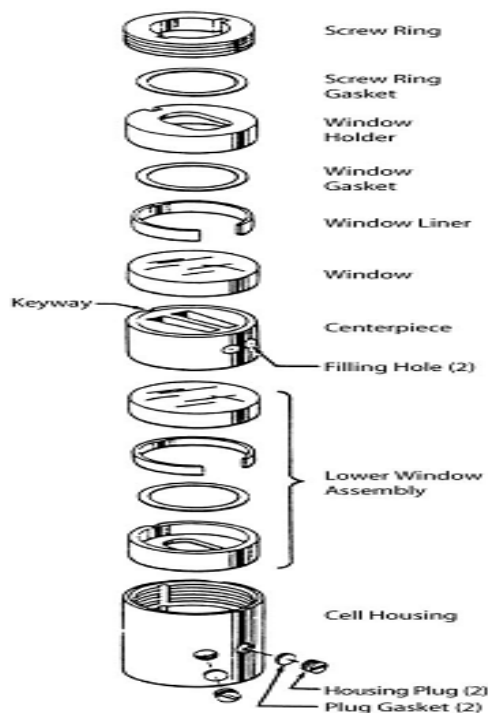


Fig 3. ultracentrifuge parts

### Detectors

Data that is obtained from a detector of dissociative ultra-centrifuge, in fact includes profile of radius velocity,  $c(r)$ , at time ( $t$ ). Detectors that are commonly used, has been using of

three properties of solution or distributed particles. These properties including: special light absorption, light dispersion and light refraction. According to these properties, different kinds of detectors are used for dissociative ultra-centrifuge.

Three important kinds of these detectors that have more application include UV detectors, interference detectors and Schieler detectors. The following figure shows a UV detector.

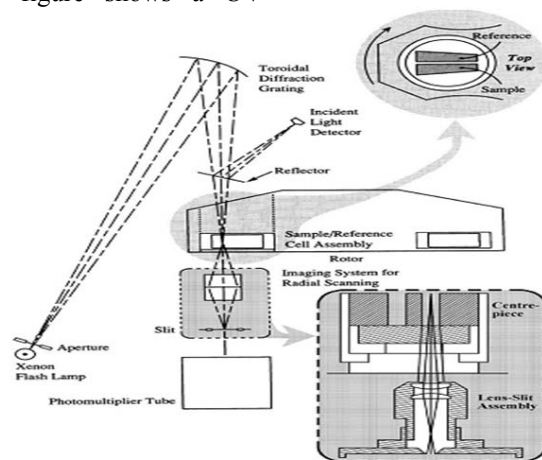


Fig 4. Setup of the UV absorption optics of the O<sub>2</sub>

#### VIII. APPLICATION OF ULTRA-CENTRIFUGES AT FOOD INDUSTRY

Ultra-centrifuges have been limitedly used in food research where it is used to determination of microbial toxins at food, study of fat oxidation during storage and processing of fat food, review of damaged starch (amylose and amylopectin), recognition of virus at food (Hepatitis A) and study of depolymerization of pectin with highmethoxyl group (HMP) at temperature range of 20 to 60 °C.

#### IX. CONCLUSION

Ultra-centrifuge is a powerful method for studying of properties of polymers, biopolymers, polyelectrolytes, nanoparticles, dispersions, emulsions and other colloidal systems. This technique is a good method for determination of molecular weight, size of particle, density of particle and determination of coefficient reaction. Almost, there is not another way for determination of molecular weight with this wide range of molecular weight. Also, using of sedimentation analysis by ultra-centrifuge can show molecular weight of complex components when are in the solution without depending on their shape. The basis of function of absorption detectors is related to spectroscopy properties. The light that is passed from a solution with molecules that have absorbing properties, its intensity decreases due to passing of it. This phenomenon is mentioned with Lambert Beer Law as follows:

$$A = \log I_0/I = \epsilon \cdot c \cdot a$$

Where, A is absorption, I is light intensity after passing from sample, I<sub>0</sub> is light intensity passing from solvent,  $\epsilon$  is decadic coefficient of special coefficient, c is density of sample and a is thickness of measuring cell at light line. At this system, a xenon lamp produces a light with 190-800

nanometer wave length. The produced light is radiated to cell having sample solution and reference solvent. From difference between intensity of passing light from solution and pure solvent that is determined by a detector, we can find out radius density of sample solution at any time.

#### REFERENCE

- [1]- Borchard, W. 1991. Progress in analytical ultracentrifugation. Springer. New York.
- [2]- Wandrey, C. and Colfen, H. 2006. Analytical ultracentrifugation VIII. Springer.
- [3]- Scott, D., J. Harding, S., E. and Rowse, A. 2005. Analytical ultracentrifugation, techniques and methods. RSC publishing.
- [4]- Machtle, W. and Borger, L. 2006. Analytical ultracentrifugation of polymers and nanoparticles. Springer.
- [5]- Millard, M., M. et al. 1999. The hydrodynamic characterization of waxy maize amylopectin in 90% dimethylsulfoxide- water by analytical ultracentrifugation, dynamic and static light scattering. Carbohydrate Polymers: 39: 315-320.
- [6]- Tester, R., F. et al. 2006. Damaged starch characterization by ultracentrifugation, Carbohydrate Research. 341: 130-137.
- [7]- Majzoubi, M. et al. 2003. Partial fractionation of wheat starch amylose and amylopectin using zonal ultracentrifugation. Carbohydrate polymers: 52: 269-274.
- [8]- Bowen, S. E. et al. 2006. Lipid oxidation and amylopectin molecular weight changes occurring during storage of extruded starch samples. J. Cereal Sci. 43: 275-283.
- [9]- Rzesutka, A. et al. 2006. A Ultracentrifugal based approach to detection of hepatitis A virus in soft fruits. Int. J. Food Mic. 108: 306-315.
- [10]- Yoon, J. W. et al. 2003. Molecular fractionation of starch by density - gradient ultracentrifugation. Carbohydrate Research. 338: 611-617.
- [11]- Gilbert, R. J. et al. Studies on the structure and mechanism of a bacterial protein toxin by analytical ultra centrifugation. J. Mol. Biol. 293: 1145-1160.
- [12]- Morris, G. A. 2002. A hydrodynamic study of the depolymerization of a highmethoxy pectin at elevated temperatures. Carbohydrate Polymers: 48: 361-368.

# Genotypic Pattern Analysis of Forage Yield in *Agropyron cristatum* by using AMMI model

Tahereh Jalili Zalpour<sup>1</sup>, \*Ali Ashraf Jafari<sup>2</sup> and Khodadad Mostafavi<sup>3</sup>

<sup>1</sup> MSc Graduated in Plant Breeding, College of Agriculture & Natural Resources Islamic Azad University, Karaj Branch, Karaj- Iran

<sup>2</sup> Prof. in Plant Breeding, Research Institute of Forests and Rangelands, Tehran, Iran, \*Corresponding Author: Email: [aajafari@rifr-ac.ir](mailto:aajafari@rifr-ac.ir)

<sup>3</sup> Assist. Prpf. Department of Plant Breeding, College of Agriculture & Natural Resources Islamic Azad University, Karaj Branch, Karaj- Iran

## INTRODUCTION

**Abstract**— In order to determine yield stability of *Agropyron cristatum* over six environments in Iran, 18 accessions were evaluated based on randomized complete block design with three replications at rainfed and irrigated conditions in Karaj, Mashhad and Boroojerd research stations, Iran. Total annual dry matter (DM) yield were collected and averaged over two years. Stability parameters were calculated as additive main effect and the multiplicative interaction analysis (AMMI). Based on AMMI analysis, the main effects of environment, accession and interaction effect of environment × accession were significant ( $p < 0.01$ ). In AMMI analysis, the first two principal component axes were significant ( $p < 0.01$ ) and justified 83.1% of total genetic by environment interaction variation. The AMMI biplot IPCA1 vs. IPCA2 scores for both genotype and environments showed  $G_7$  and  $G_{11}$  accessions were close to the center of the biplot and had the least interaction based on both two components and were considered as more stable accessions over all tested environments. Accessions  $G_2$ ,  $G_{16}$ ,  $G_{17}$  and  $G_{12}$  had the highest specific adaptation to rainfed condition. In contrast,  $G_{14}$  and  $G_8$  accessions had the highest specific adaptation to irrigated environment of Mashhad and similarly,  $G_3$ ,  $G_7$ ,  $G_{18}$ ,  $G_{15}$  and  $G_6$  accessions had higher specific adaptation to the irrigated environments in Boroojerd.

**Keywords**—*Agropyron cristatum*, DM yield, genotype × environment interaction, stability, AMMI model

DM yield is a complex trait which is depended on yield components and is highly influenced by many genetic as well as environmental factors [1]. Therefore, evaluating genotypic potential in different environments is the important step in breeding programs of grasses species before selecting desirable ones to commercial cultivation. An ideal variety should have a high yield mean combined with a low degree of fluctuation, when grown over diverse environments. Analyzing Genotype and environment (GE) interaction for varieties can reduce errors in the breeding process for proper selection by multiple locational conditions [2].

The additive main effect and the multiplicative interaction analysis (AMMI) are widely used for GE interaction investigation [3]. This method has been shown to be effective because it captures a large portion of the GE interaction sum of square. It clearly separates GE interaction effects that present for agricultural researchers with different kinds of opportunities, and the model often provides agronomically meaningful interpretation of the data [4]. The results of AMMI analysis are useful in supporting breeding program decisions such as specific adaptation and selection of environment as observed by Gauch and Zobel [5]. According to Gauch et al. AMMI is superior for agricultural since AMMI partitions the overall variation into genotype main effects, environment main effects, and GE interactions [2]. These three sources of variation present agricultural researchers with different challenges and opportunities, so it is best to handle them separately [2].

Successful varieties are those that which are better in terms of yield and other agronomic traits, also their superiority should be reliable in different environmental conditions [6]. In

AMMI method additive main effect analyzed by using common ANOVA and then GE interaction that is known as multiplicative interaction analyzed by PCA [7]. Farshadfar et al. and Zohrabi et al. used AMMI analysis method to evaluation forage yield stability of *Agropyron* genus here In Iran. However, for other grass species there are less reports for AMMI analysis [8, 9].

The objectives of this study were to evaluate forage yield performance and stability of 18 accessions of *Agropyron cristatum* using AMMI method to identify accessions that are widely adapted (stable) and specifically adapted (with narrow adaptation) for DM yield.

### MATERIALS AND METHODS

Performance stability of 18 accessions of *Agropyron cristatum* species was evaluated using randomized complete block design with three replications under two different environments (irrigated and rainfed) at the three research station contains; Mashhad, Brojerd and Karaj, Iran. The climate Brojerd is moderate semiarid with annual precipitation above 400 mm. The climate of Mashhad and Karaj is cold semi arid with annual precipitation between 250-350 mm. The drought period of three stations is four months of year and wet season starts in October and it continued until May [10].

The 18 accessions of *Agropyron cristatum* (originated from different parts of Iran) were provided from natural resources gene bank (Research Institute of Forests and Rangelands, Iran) (Table 1). The seeds were sown as 15 kg<sup>-1</sup> in four drilled lines as long as 2m with 25cm distance in sward condition using randomized complete block design with three replications in autumn 2009. In Irrigated experiments the irrigation was made according to the plant requirement, but for rainfed condition no irrigation were made. Weeds were control mechanically and fertilizing schedule was made based on scientific advices and recommendations. In establishment year, plots were cut once, but no data were measured. In 2010 and 2011 plots were cut for two times for DM yield. Then, the total annual DM yield was averaged over two years and consequently were used for combined analysis over six environments.

For AMMI analysis to the model proposed by Clay *et al* was used [11].

$$Y_{ger} = \mu + \alpha_n + \beta_e + \sum_n \lambda_n \alpha_{gn} \gamma_{en} + \rho_{ge} + \varepsilon_{ger}$$

Where:

$\alpha_n$ =main effect of genotype,

$\beta_e$ = main effect of environment,

n=the number of axes components of the residual interaction in the AMMI model,

$\lambda_n$  =the n-th singular value of the remaining principal components in the model

$\alpha_{gn}$ =eigenvector for g-th genotype of n-th principal component interaction,

$\gamma_{en}$ =eigenvector for e-th of the n-th principal component interactions,

$\rho_{ge}$ =noise and  $\varepsilon_{ger}$  experimental error [11].

Combined analysis of variance over six environments was used to estimate mean square of accessions, environments and accessions × environments interactions. Accession stability was evaluated on the bases of accessions × environments interactions. The G x E interaction effects were estimated using the additive main effects and multiplicative interaction analysis (AMMI). In the AMMI model the additive part of the model is estimated by ANOVA and the multiplicative part is estimated by the principal component analysis[ 12].

The AMMI analysis was processed using IRRISTAT. The IPCA1 versus mean yield and the first two principal components were biplotted and used to illustrate the relationships among accessions and environments.

Table 1. Gen bank name, code and origin of accessions of *Agropyron cristatum*.

Code	Name	Origin	Code	Name	Origin
G1	1722m	Gorgan	G10	P <sub>8</sub> 208	Karaj
G2	1727m	Gorgan	G11	208s	Karaj
G3	P <sub>10</sub> 172	Gorgan	G12	4056m	Isfahan
	7				
G4	P <sub>12</sub> 172	Gorgan	G13	P <sub>1</sub> 405	Isfahan
	7			6	
G5	P <sub>7</sub> 1727	Gorgan	G14	P <sub>2</sub> 405	Isfahan
				6	
G6	208m	Karaj	G15	529m	Hovare
G7	P <sub>10</sub> 208	Karaj	G16	619m	Isfahan
G8	P <sub>13</sub> 208	Karaj	G17	P <sub>13</sub> 619	Isfahan
G9	P <sub>2</sub> 208	Karaj	G18	619s	Isfahan

### RESULTS AND DISCUSSION

AMMI analysis were made on 18 accessions in both conditions of three sits in total six environments based on the model proposed by [11]. The results presented in Table 2. The additive effects of accession and environment were significant (P<0.01), therefore, significant different between six environments and between accessions were existed for DM yield. It should be noted, the multiplicative main effect of environment and accessions were assigned 59.17% and 6.24% of total variation, respectively (Table 2). So, it can be said that variation due to environmental effect had more impact than the main effect of accessions on the diversity of forage yield. Accessions × environment interaction was also significant (P<0.01) and accounted for 15.21% of the total variation. Therefore, accessions × environment interaction for yield was less than the environment effects and higher than the accession effect. The obtained data confirm adequacy to the AMMI model. This made it possible to construct the biplot and calculate genotypes and environments effects [13].

In order to better interpret the accession  $\times$  environment interaction principal components of interaction were extracted, as shown in Table 2. The first, second and third component of interaction, justified 52.55, 30.85 and 9.39% of total GE interaction, respectively. The first two principal component axes were significant ( $p < 0.01$ ) and justified 83.1% of total GE interaction. The AMMI biplot IPCA1 vs. IPCA2 scores for both genotype and environments are shown in Fig. 1.

According to the AMMI biplot, the reaction of accessions was different in irrigated conditions than under rainfed conditions and consequently environmental vectors in irrigated conditions had greater angle relative to each other and the studied three areas are roughly in three different directions. In contrast, for rainfed conditions, the angles between the environmental vectors were low and the response of accessions was less than that in rainfed conditions. This can be interpreted as the more effect of irrigation and increased in GE interaction in irrigated conditions.

For Karaj environments the vectors of both irrigated and rainfed conditions are in the same direction and also rainfed experiment of Mashhad had similar trend as Karaj environment. For other three environments including irrigated Mashhad, irrigated Boroojerd and rainfed Boroojerd had different direction.

The AMMI biplot IPCA1 vs. IPCA2 scores for both genotype and environments showed  $G_7$  and  $G_{11}$  accessions were close to the center of the biplot and had the least interaction based on both two components and were considered as more stable accessions over tested environments.

Accessions  $G_2$ ,  $G_{16}$ ,  $G_{17}$  and  $G_{12}$  had the highest specific adaptation to rainfed conditions. Therefore, we can say these accessions in rainfed conditions were more suitable than the other accessions. In contrast,  $G_{14}$  and  $G_8$  accessions had the highest specific adaptation to irrigated environment of Mashhad and similarly,  $G_3$ ,  $G_7$ ,  $G_{18}$ ,  $G_{15}$  and  $G_6$  accessions had higher specific adaptation to the irrigated environments in Boroojerd. Other accessions did not show a high public or specific adaptability. Similar to this finding, Madaini evaluated specific and general adaptability of 24 accessions of *Agropyron trichophorum* to irrigated and rainfed conditions in Kermanshah using GE biplot and AMMI model and identified and introduced the accessions whit public and specific compatibility [14].

Table 2. Combined analysis of variance of DM yield and SS% from the AMMI model over 6 environments

S.O.V	DF	SS	MS	SS%	Interaction Variance %
Accession	17	5429103	319359**	6.24	
Environmen	5	5151821	10303642*	59.1	
t		0	*	7	
Accession $\times$	85	1841270	216620**	21.1	
Environmen		0		5	
t					
IPC1	21	6676170	460770**		52.55
IPC2	19	5680020	298948**		30.85
IPC3	17	1728270	101663		9.39
Noise	28	1328240	47437		7.21
Ererr	21	1170362	54183		
	6	4			
Total	32	8706363			
	3	7			

\*\* =Significant at 1% probability level.

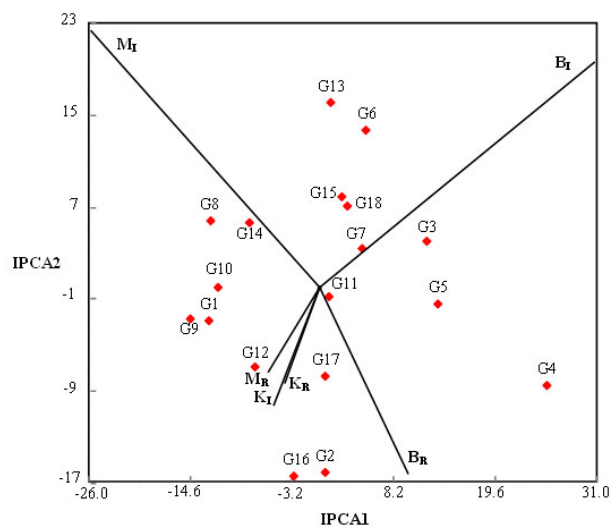


Fig 1. AMMI Biplot of the first and the second IPC for 18 genotypes over 6 environments

( $G_1$  to  $G_{18}$  = Accessions code as presented in Table1)

( $M_I$ =Mashhad Irrigation,  $M_R$ = Mashhad rainfed)

( $B_I$ = Boroojerd Irrigation,  $B_R$ = Boroojerd rainfed)

( $K_I$ =Karaj Irrigation,  $K_R$ = Karaj rainfed)

( $G_1$  to  $G_{18}$  = Accessions code as presented in Table1)

## REFERENCES

- [1] Falconer, D. S and T. F. C. Mackay, 1996. Introduction to quantitative genetics, *Fourth edition*. Longman Group Ltd. London, 464 pages.
- [2] Gauch, H.G., H.-P. Piepho and P. Annicchiarico. 2008. Statistical Analysis of Yield Trials by AMMI and GGE: Further Considerations *Crop Science* **48(3)**: 866-889.

- [3] Gauch, H. G. and R. W. Zobel. 1989. Accuracy and selection success in yield trials. *Theor. Appl. Genet.* **77**: 473-481.
- [4] Ebdon, J. S. and H. G. Gauch. 2002. Additive main effects and multiplicative interaction analysis of national turfgrass performance trials. II Genotype recommendation. *Crop Sci.* **42**:497-506.
- [5] Gauch, H. G. and R. W. Zobel, 1997. Identifying mega-environments and targeting genotypes. *Crop Sci.* **37**: 311-326.
- [6] Amundson, R., 1996. Historical development of the concept of adaptation. P. 11-53. In Rose. M. R. and lauder, G. V. (eds), *Adaptation* Academic press, Santiago.
- [7] Crossa, J., H. G. Gauch and R. W., Zobel. 1990. Additive main effects and multiplicative interaction analysis of two international maize cultivar trials. *Crop Science* **30**:493-500.
- [8] Farshadfar, M., F. Moradi, A. Mohebbi & H. Safari. 2010. Investigation of yield stability of 18 *Agropyron elongatum* genotypes, in stress and non-stress environments, using AMMI model. *Iranian Jour. Rangelands and Forests Breeding and Genetic Research*, **18**:41-54. (In Persian)
- [9] Zahrabi, A., A. Etminan,, H. Safari, and A. A., Jafari, 2011. Forage Yield Stability in accessions of *Elymus hispidus* species and other methods of stability analysis and AMMI Model in both stress and non-stress environments. *Rangelands* **5** (2): 209-218(In Persian).
- [10] Badripour, H., N., Eskandari, and S. A. Rezaei 2006. "Rangelands of Iran, an Overview". Ministry of Jihad-e-Agriculture, Forest Range and Watershed Management Organization, Technical Office of Rangeland, Tehran, Iran, (<http://www.fao.org/ag/AGP/AGPC/doc/Counprof/Iran/Iran.htm>).
- [11] Clay, H., Sneller, C. H. and Dombek, D., 1995. Comparing Soybean cultivar ranking and selection for yield with AMMI and Full-Data performance estimates. *Crop Science* **35**: 1536-1541.
- [12] Zobel, R.W., M.J. Wright, and H.J. Gauch, 1988. Statistical analysis of yield trial. *Agronomy Journal* **80**:388-393.
- [13] Gauch, H. G. and R. W. Zobel. 1996. AMMI analysis of yield trials. In Kang, M. S. and Gauch, H. G. (eds). *Genotype by Environment Interaction*. CRC Press, Boca Raton, pp. 85-122.
- [14] Madaini, H. 2012. Comparison of different methods of stability analysis for yield accessions wheatgrass (*Agropyron trichophorum*) in irrigated and dryland of west of Iran. Thesis submitted for MSc degree, Islamic Azad University, Borojerd branch, Borojerd Iran.



# The analysis of organizational education and training system from economic view and human capital and its role in sustainable development

Reza Hosseinpoor<sup>1</sup>, Morteza Karami<sup>2</sup>

**Abstract**-The social organizations are some of the foremost phenomena at present time. Many requirements are met by organizations in modern world. By the aid of their resources including technology, information, financial sources, and human capital the organizations meet the social requirements. The human capital of the organizations is deemed as the paramount and most effective organizational sources since other sources are perishable but the human capital can be developed. To realize this objective, the reviewing scientific method has been employed. The results of this investigation indicate that the growth and excellence of human capital in the organizations might be only possible through organizational education and training. This issue suggests that organizational investment in growth and development of human capital is more efficient than investment in physical and equipment- related dimensions and it contributes the organizations in realization of their goals and growth and development of organizations will help to national growth and sustainable development from various dimensions. Thus, organizations should change their attitude from equipment- centered view to education and learning- centered approach. Of course, fulfillment of this important point requires serious investment in the field of training and education.

**Keyword**-Organizational Education and Learning, Human Capital, Economy of Education and Training, Sustainable Development

## I. Introduction

Rather than making effort for growth and flourishing the potentials in personnel and directors, organizational education and learning tend to create and improve the needed capabilities in personnel for efficient doing of their occupational tasks based on occupational and

organizational requirement. It is obvious that along with complexity of conditions in the organizations, the organizations are placed under new conditions and as a result the personnel will need to new abilities.

The modern system of organizational education and learning requires investment in all dimensions. It is a matter of fact that in order to design and execute this system efficiently, the economic, human, social, and cultural dimensions of this field should be accurately analyzed unless otherwise it is possible for the analysts to become confused with only an economic outlook at this system and they may be moved to this point that organizational education and learning is not cost-effective.

Education and learning are assumed as the most essential and foremost mechanisms for training of organizational human resources. The organizations have no alternative except for development and improvement of education and learning process to train the professional manpower. On the other hand, education and training is a cost-consuming activity and a major part of organizational capital and incomes are devoted to it. Lack of a comprehensive analysis in economic, cultural, social, organizational, and design dimensions and especially execution of education and training system may expose the organizations to some challenges. The present research is intended to study and explore the education and training system from the perspective of human capital and economic view and role of both of them in sustainable development. To meet this end, the researcher should search for and find the answers to the following questions:

- 1- What are the paramount attitudes in analysis of investment in the field of training and human resources?
- 2- How can educational and learning investments be justified from economic viewpoints?

---

<sup>1</sup> - Assistant professor in Comprehensive University of Imam Hossein, Iran.

<sup>2</sup> - A researcher in Comprehensive University of Imam Hossein, Iran.

3- What is the effect of organizational education and training systems on growth and development of human capital and finally on sustainable development?

Overall, doing a series of special and certain tasks and practices is necessary with respect to *raison d'être* of human resource organizations and various social institutions in human communities. These are the practices regardless of which the community could not survive. In this course, several personnel and human resources and manpower are employed and used in these social organizations to do some of the special tasks assigned to the given organization through planning, management, activity, supervision, and executive measure. In other words, each of organizational members composed of manager, CEO, chief, and subordinate does specific task. Simultaneously with developing science and technology and being more specialization of administrative and organizational jobs, the social organizations hold special various theoretical and practical trainings for the personnel after attracting them and before employing them during several phases and depending on sensitivity and the needed expertise of the given task. It is clear that profitability and effectiveness of such specialized and organizational trainings may be realized when they are aligned with the fundamental goals and missions of the organization and they are organized proportional to nature and essence of the given organization. Thus, extraction of general educational principles and fundamentals is necessary and required beforehand; the principles which each of organizational personnel or members should learn them only because of presence in an organization with any administrative and specialized position and they should be considered and utilized as the basic principles of training at phase of planning for educational courses and in codification of textbooks. As a result, one can discuss about the compliance of educational bases in an organization with missions and tasks of that organization on the one hand and essence and nature of the organization on the other hand.

## II. Theory and history of research

### II-1- Human resources educational and training system and its objectives

From the very beginning, education and training have played essential role in the rites and customs, beliefs and values, attitudes and behaviors, and knowledge and skills in the community have been transferable and continued through educational and training systems. The main mission of educational systems should be introduced as proper training of human resources. It is the proper training that is the main objective in any educational system and it

may enable the personnel to achieve human and divine values since the potential talents of human will be gradually actualized in light of proper education and training and they grow and are developed (Vahidi, 2001).

The educational system is responsible for important tasks and practices including culture transfer (cultural transferability), social training (sociability), professional and expert training, innovation and comprehensive growth of personality for the personnel. The efficient educational system is one that considers uniformly human from various moral, rational, emotional, and physical aspects so that the human can be prepared for execution of basic mission as the organizational capital with the maximum level of competency and efficiency.

With respect to various missions and tasks in organizations, the education and training possess different essence and goals out of which one can mention the foremost common goals which are noticed in organizations as follows:

1. Increase in knowledge, information, and professional capability and preparation of personnel for doing new tasks and responsibilities
2. Creating appropriate behavior and proportional to stable values in community of personnel
3. Rising job satisfaction and improvement of spirit and correlation among personnel with organizational objectives
4. Creating spirit of collaboration and cooperation among personnel toward organizational goals
5. Preparation of grounds for growing creativity and flourishing and innovation in personnel
6. Reducing job accidents and losses and various organizational costs
7. Contribution to organizational changes under necessary conditions (ibid, pp 126-127)

### II-2- Economy of education

As the most integrated branch of social- human sciences during its development period and with respect to the facts in industrial communities and given the developments caused by constant change and developing technology and industrial structure, the economics has been exposed to several problems and it has presented the applied strategies and new theories in order to give solution and or for interpretation of modern economic realities caused by

behavior of actors (family, enterprise or government) in these communities. Some of these theories have led to arising of new branches in economics. On the other hand, with respect to the personal interest and researching plans in which they participate, the researchers in social sciences employ the knowledge as a tool to analyze various issues and with respect to the facts in their given community even in some fields such as, economy of divorce, economy of theft, rent economy and the like (Emadzadeh, 2003).

The economy of development or economy of education is deemed as these types. However, economics has referred to relationship of training with human capital and thus long run development in the communities from the point of its birth, the economy of education has drawn the attention from some of economists as one of the applied branches of economics during past decades.

The theoretical economy of education is usually concerned with 1) Determinant factors for presentation and selection of training for the economic benefits out of personal cost (investment) in education and future profits in the fields of wage and income; 2) The effects of training on individual and the community where s/he lives in and long run economic- social development; and 3) The needed recommendation for the efficient reforms in educational system. Theories proposed by some researchers like Becker and Barro within the narrow economics – in neoclassic major denotes emphasis remained on cost- profit analysis in short term while the more essential role of education in economy is to develop the current value- driven system and transferring it to a system proportional to industrial and trans- industrial age for comprehensive socioeconomic development and intellectual- cultural flourishing and creating civilization transformations. Regardless of such development, the needed institutional and organizational reforms will not succeed for economic development (ibid, 87).

The points derived from history of growth of modern economy suggest that by aiming at fast growth to achieve economic position in advanced industrial world like some of countries in southeastern Asia, the less- developed countries have tried to invest further in education sector with respect to their economic capacity.

#### II-3- Analysis of training investments from economic theories viewpoints

One of the serious topics in the field of economy of education is to explore the relationship among organizational training and learning with productivity of human capital in workplace. The main question is that if

there is any relationship among education level in personnel and the rate of their productivity. The history of study on relationship among education and productivity in developed nations returns to 1960s when for the first time some economists like Meisner and Schulz tried to justify and interpret this relationship logically and with respect to academic criteria. During four past decades, they have shown the research developments in this regard within various dimensions. The scientific findings indicate that the relationship among productivity and education could be examined and analyzed by using four major theories under titles of theories of human capital, screening, filter, and interaction with technical changes (Mardiha, 2003).

Most of researches could indicate the undeniable relationship among education degree, income level, rate of productivity in human resources, and economic growth. It should be implied of course that the empirical evidences and the conducted researches, which confirmed these theories, have mainly demonstrated the effect of education on rate of productivity at microeconomic level and through study on performance of personnel inside the factories and industrial and agricultural centers. Hence, it necessitates conducting further researches and at macroeconomic level (regional and national) as well so that to clarify existing of this relationship. In any case, the classic theories of microeconomics were argued that the education might affect on productivity by three ways. The first is that the education trains valuable skill to the personnel and it causes rising the rate of their exploitation in the business and for this reason the directors should also increase their salaries and income by improving their educational degrees. This attitude is confirmed according to human capital theory. Secondly, education does not grant any valuable skill and feature to the personnel, but it only puts some information at directors' disposal thereby they can recognize high-quality personnel from ones with lower quality. As a result, education and training is only deemed as one signal (sign) and thirdly education does not increase rate of productivity but give this opportunity to ones, who are more benefitted from it to act in more dynamic professional environments while dynamics of environment is a factor that improve rate of productivity in human resources per se (Emadzadeh, 2003).

#### II-4- Human capital theory

The main theme in all the theories which are concerned with economy of education is to define the relationship among the educational system with economic phenomena including employment market, productivity of human resources, the relationship among employee and employer,

theory of salaries and wage and job satisfaction level. The human capital theory is one of most well-known theories, which possesses longer history and background.

Adam Smith, father of economics, may be assumed as the first person, who was interested in using economic theories in research and study on social relations. In fact, Human Capital Theory expresses that from individual's point of view the education is deemed as investment. The value of this training includes direct and indirect monetary costs, which a person or organization has to pay for its achievement and or dispense with them. If the future benefits are higher than value of costs, the education will be profitable and long run investment for the person and organization. In addition, the value of social benefits of education should not be also ignored. Thus, it can be mentioned that human capital theory tends to prove this assumption that the human is the foremost factor among the effective factors on production process. This paradigm from Adam Smith was agreed by the economists based on which with education the humans may be converted into capital and wealth for them and community (Vahidi, 1994).

The human capital theory looks at education and training as a type of investment in skills and assumes it as a method to increase productivity rate of human resources. This paradigm is led to presentation of some growth models in which the productivity is assumed as the result of various performance caused by change rate of access to education. The primary studies in this regard signify this fact that educational changes strongly affect on economic growth. For example, Denison (1979) estimated that about one-fifth of growth in US national income during years (1948-1973) can be attributed to rising of educational level in human resources in organizations. Regarding qualitative improvement in US human resources, the investigation done by Jorgensen and Frameni (1993) assumes one fourth of economic growth during years (1948-1968) caused by rising level of literacy in human resources. Similarly, study on economic growth among six member states in Organization of Economic Cooperation and Development (OECD) for seventy-year time period (1913-1984) indicates that more access to education may highly justify the growth of productivity rate during this period (Wolff, 2007). The aforesaid research findings shows this point that the higher rate of enrollment at high schools and higher education among the employees at age higher than 15, the higher productivity rate will exist in human resources as well. So as a result, it can be implied that productivity rate in workforce in developed countries is higher than in developing nations.

II-5- Economic applications of human capital theory in training and education of human resources

As the economists define, human capital theory proposes a very simple interpretation about role of education. Passing through various educational courses creates several skills, knowledge, insight, and capabilities for which there is some demand in the market. This causes that the given person to achieve further occupational opportunities with higher income if s/he receives more training. The education is generally deemed as public education while special trainings (specialized and professional) are postponed to the time when the person is employed (Bills, 2003).

In Becker's opinion, the educational system provides the needed conditions for the person to acquire occupational and professional capabilities by presentation of primary and basic trainings, but what it causes distinction of a person to other one is the superiority in special and professional skills, which are acquired by participation in the higher education centers or on-the-job training courses.

Another application of human capital theory is to pay attention to time factor as a type of valuable restricted capital and its relation with subject of education. Time-education relationship can be notices regarding some issues including educational risk-taking and emigration (immigration).

The most interesting point of Becker's theory should be search in application of human capital theory to define behavior of the educated persons in relation with the family institution and what it called 'economy of family'. This relationship forms from the very beginning phases so that as the educational level is increased in human capital, the prices of time that s/he allocates to a certain subject will be also increased. Here, Becker refers to human capital proportion in marriage and calls high quality as marriage of high-qualified men with the women. As a result, if a man with high quality of human capital chooses a woman with the similar quality as his wife, this marriage can be called positive unity (Sandemo, 1994). According to Becker's view, some issues like business and income of family, demand for child and time and their quantity, training of children, and leisure times all have several economic effects and consequences are exactly affected by size and amount of human capital from which the spouses are benefitted. For instance, one can notice the relationship among period of child-bearing with economic growth and role of human capital in it. When the economy grows, the rate of birth is reduced so the rate of enjoying education is improved so the mean age for childbirth rises. According to opinion of

Becker and Barro, improvement of education will also develop technological advancements (Becker and Barro, 1988).

What it can be mentioned according to human capital theory about education and training system is that the investment of organizations in training and education of directors and experts includes several individual, organizational and even familial effects. The growth and training of personnel improves their capabilities and whereas education and training system creates and improves new knowledge and skills in the learners then it will cause the works to be done with lower economic and social costs and this will lead to economic growth in the long run.

In addition, time is important as a significant element in activities of organizations. The educated personnel appreciate more value for the time and use it better.

In addition to these direct effects, education and training of personnel increases their familial satisfaction. The educated persons are potentially able to moiré appropriate marriage, more proper training for the children, and adaptive resolving of their own familial conflicts. The familial appropriate conditions for the personnel improve their organizational actions.

#### II-6- Economy of organizational higher education

The second half of twentieth century can be assumed as the time of emerging of economic view toward educational system and in particular the higher education. The phenomenon of globalization has played essential role in emerging and spreading of this attitude. The globalization phenomenon tried to introduce higher education as a jumping platform for economic development and to demonstrate its practical and technical value. The achievement in higher education is deemed as rising access to scientific researches, which leads to holding race and competition at individual, organizational, and national levels. This competition spreads within the borders between universities and among higher education centers at international level and enter them in modern classification of the developed, developing, and retard groups. If the countries were shown by means of terms and division and position of them in world economic cycle yesterday, these are universities and higher education centers which are characterized by one of these features today and they are no longer assumed as winners or losers of economic lexicons and or exclusively specified to financial and material investors. At this time, new winners and losers are members

of faculties and universities. The latest research findings indicate that the learning is the key for arrival at knowledge- based community and anyone can build and produce knowledge through training (Brewer et al, 2003).

According to this attitude, the universities and higher education centers in organizations are assumed as the key for economic growth in the given organizations. Thus, the economic analysis of higher education is deemed as a new opportunity for the universities in the knowledge- based economy. Under this condition, the universities and higher education centers are considered both as effective factors for economic growth and as a new and intact ground for profitable activities such as a new and attractive industry for investment by the investors (Kerr, 1982). For this reason, some analysts like New (1988) argues that the education in general and higher education in particular have lost their position as a social procedure and policy everyday more than ever and they are noticed growingly as economic tools while the sociologists, politicians, planners, and directors and even parents mostly utilize from so-called terms among the economists- which denote economic view toward the education- like rate of return, growth in human interests, effectiveness, efficiency, productivity, and personal cost creation (Watson, 1996).

Dominance of economic view to education is manifested, especially about higher education so that during two final decades of twentieth century even in China- that claimed developing education as main tools for realization of social justice- it was assumed as a type of investment in human capital. For this reason, it can be anticipated that in twenty first century, investment in education and especially in higher education will be converted into the greatest field of economic investment in organizations and communities (Jones, 1996).

#### II-7- Science and technology

Contribution to growth and improvement of Information Technology (IT) is one of the consequences of organizational education and training system in the organization. Information Technology and Communication (ITC) has provided valuable opportunities for economic and social development based on information to organizations (Sarkar Arani, 2005). If economic superiority was a function of natural resources and ratios of production factors (coefficients of capital to labor) in the past, but human's brain is deemed as essential factor today. Compared to the previous centuries, twentieth century and the current century possess a lot of advantages, but probably none of them is as valuable as the factor of

scientific development. Before Gutenberg's invention of printing at the half of sixteenth century, Europe presented about 1000 books every year. Four and half century later (1950), this number became 120000 (UNESCO Regional Summit, 1991). In 1965, the quantity of world daily journals was about 1000 titles while today the size of existing data in a normal CD is more than 2000 books with 200 pages in normal size (Khalkhali, 2002). These quantitative developments show the fast changes in the field of human sciences and knowledge. The resulting outcomes from the fast changes in field of knowledge can be mentioned at least in five cases. These cases affect on higher education system more than ever:

- *Instability*: It means the information and data are quickly reorganized.
- *Outdated nature*: Some information becomes quickly old and useless.
- *Professional and occupational multiplicity*: It means that a person has to change his/ her job periodically.
- *Continuous training and apprenticeship*: That is the learning is assumed as a permanent process and a tool to adaptation to new circumstances.
- *Communication network*: It means that the data and information can be widely disseminated and spread (Abbasi and Madandar, 2000).

In fact, the governing new paradigm over economy of education is based on this assumption that the education provides the maximum benefit for personnel and organizations and tendency to participate in educational institutes is deemed as an individual choice and decision to access to employment market at better position. This approach causes creating the possibility for competition among personnel to further, faster, better access to education that is not necessarily negative since individual mobility and progress will be finally followed by constructive social outcomes (Sarkar Arani, 2005).

II-8- Economic outcomes of organizational and higher education and their role in sustainable development

The education and in particular organizational and higher education has been further noticed than other educational courses due to economic outcomes and it has been considered as one of the main reasons for development of countries and organizations. This issue is especially addressed in analysis of economic growth at countries from southeastern Asian region by the economists. The studies

which have been mainly conducted during two past decades witnessed this effect so that the findings of research from Li and Liu and Wong (1994) show that the economic growth in two countries of South Korea and Taiwan has been mainly affected by their human capital. Also in his research, Lin (2003) tried to examine the undeniable effect of higher education in economic growth in Taiwan so that one percent increase in capital for higher education have led to 19% increase in production of this country during the given period of time (Lin, 2004). Voon (2001) had acquired the similar results to findings of Lin's research in Hong Kong during 2001. Similarly, the investigation of Tilek (2003) about relationship among organizational and higher education with Human Development Index and parameter of sustainable development showed in 49 Asian countries that in these communities:

- There is strong relationship among organizational and higher education with economic sustainable development.
- The rate life expectancy is increased and childbirth rate is reduced with spreading organizational and higher education.
- The marriage methods are changed and its age is postponed.
- A very negative strong relationship is observed among rate of enrollment in higher education with poverty; and
- A very positive strong relationship is seen among rate of enrollment in higher education with rising income level.

One of the most distinct economic effects of organizational and higher education system can be searched in relationship between universities and work market and employment system. However, this relationship does not express new subject and the economic planners are aware of its importance for several years, intensification of world competitions requires looking more deeply at performance and position of organizational and higher education systems. It is clear that the large- size and leading enterprises tend to choose their needed human resources among the educated persons of the best universities since labor market is classified according to value and reputation of enterprises. On the other hand, the universities and higher education institutes are also ranked according to the opportunities, which are created for employment of their graduates in large- size and leading organizations and enterprises. In fact, a mutual relationship and effect have been created among system of employment with higher education system. For this reason, employment of

graduated people from higher education centers measures the effectiveness of higher education like an economic criterion (Sarkar Arani, 2003).

When Castles (1996) divided world workers into four main groups of high- value laborers (Knowledge- Workers), producers with high- capacity (workforce with lost cost), producers of raw materials, and unemployed producers (workforce without value), he apparently showed that the knowledge- workers are the product and output from a modern and dynamic higher education system. For this reason, the subsequent changes during recent years exerted in higher education system at developed countries and proposing some subjects such as accreditation in universities indicate that there is a very close and interrelated competition among these institutes. Rather than proving the universities as the paramount centers and sources of training of knowledge- based workforce in this competition, they have been involved in perfect competitive economy to attract financial sources. This competition conveys a completely clear message:

**Table 1:** Composition of national wealth based on role of investment in various points of the world for 1994

Geographical zone	National wealth (based on per capita for one thousand million USD dollars)	Human capital (in percent)	Physical capital (in percent)	Natural capital (in percent)
North America	326	76	19	5
Western Europe	237	74	23	3
Middle East	150	43	18	39
South America	95	74	17	9
Eastern Asia	47	77	15	8
South & east of Africa	30	65	25	10
West Africa	22	59	18	21
South Asia	22	65	19	16

### III. Conclusion

Despite of historical background, it has been only during several past decades that the economic growth theories has assumed role for education and training system in formation of national wealth (human capital). Before this time according to viewpoint in these theories, economic growth was assumed as the result of population growth and technological advancements and this fact did not matter that education might play role in rising national wealth. In any case, the further researches proved that among various forms of capitals, the human capital has the greatest share in formation of national wealth. The comparative study by World Bank has identified the share of investment types in formation of national wealth separately based on various regions in the world and for 1994. As it shown in Table (10), the World Bank has evaluated composition of national wealth separately based on three types of human, physical, and natural capitals and due to difficulty in measurement and conversion of quality into numerical quantity, the role of social capital has not been addressed. Nonetheless, the given findings are evident that the share of human capital in composition of national wealth is ranged from two third to three quarters in all regions of the world- except Middle East region. Similarly, the portion of physical capital is among one quarter to one sixth in all of regions. It is interesting that the natural capital has very little share in national wealth at advanced areas in the world so that the portion of this capital in national wealth is less than 5% in advanced areas of the world namely North America and western Europe. Inversely, the portion of human capital (43%) in formation of national wealth at Middle East is even less than in southern, eastern, and western countries in Africa. This finding may clearly demonstrate the *raison d'être* for economy of education and show that all of the efforts and measures, which have been made by economists to enrich this field of studies is based on this fact that despite of richness of natural capital, the educational investment in any country and in each of educational courses and for any person- female or male- includes a lot of benefits, which could never be ignored. This issue suggests that investments of organizations in growth and development of their human capital will be more efficient than investment in physical and equipment- related dimensions and it may contribute the organization to realize their goals. It seems that the managers of organization should move toward changing the approach from equipment- centered to education and training- centered attitude so realization of this important objective requires serious investment for education and training and if such an important and profitable investment is done by all large and

small public and private organizations, it will certainly play great role in sustainable development.

IV. References

- [1] UNESCO Regional Summit (1991), "Education and training for the future", Tehran: educational research center, Ministry of Education.
- [2] Bordeaux, Pierre (2003), "New capital", *Ettelaat political- economic information monthly*, transl. Mardiha, Morteza, vol. 17, pp 11-12.
- [3] Haddad, Vadi, Drexler Alexander (2005), "Technology for education: Potentials, parameters, and outlooks", transl. Sarkar Arani, Mohammad Reza & Moghadam, Alireza, Tehran: Sogand Pub.
- [4] Khalkhali, Morteza (2002), "Pathology of educational planning system of Iran and strategies for their adjustment", Tehran: Sogand Pub.
- [5] Sandhu, Agnar (1994), "Garry Becker: Nobel laureate 1992: Economics, a science composed of human behaviors", *Journal of selected news of economic issues*, transl. Mohammad Masoud, 11<sup>th</sup> year, vol. 139.
- [6] Saha L. J. Fijerlind, I (2001), "Education and development", *Encyclopedia of economy of education and training*, transl. Vahidi Paridokht, vol. 1, Tehran: education and training research center
- [7] Sarkar Arani, Mohammad Reza (2005), "Learning: A path toward filling digital gap", Tehran: Tarbiat pub.
- [8] Shamsi, Zahra (2007), "Prerequisites for knowledge- based economy", *Weekly of labor market*, Tehran: Jihad-E-Daneshgahi.
- [9] Azimi Arani, Hossein (2006), "Underdevelopment circuits in Iranian economy", Tehran: Ney pub.
- [10] Emadzadeh, Mostafa (2003), "Economy of education and training", Isfahan: Jihad-E-Daneshgahi.
- [11] Farasatkah, Masoud & Kebriayee, Ahmad (1998), "Higher education in twenty first position: A report from world conference on higher education- 1998", *Quarterly of research and planning in higher education*, 6<sup>th</sup> year, vol. 7.
- [12] Foyoozat, Yahya (2003), "The role of university in national development", Tehran: Arasbaran.
- [13] Lewis, Catherine (2006), "Training of hearts and thoughts", transl. Afshin Manesh & Ilbeigi Shideh, Tehran: Sazokar pub
- [14] Mark, Allen (2008), "Organizational University", transl. Imani Mohsen, Aghajani Saber, Tehran: Iranian Association of Human Resources Development.
- [15] Cooke, P. Clifton, N. and Oleage. M. (2005). Social Capital, Firm Embeddedness and Regional Development, *Regional Studies. Regional Studies*, 39.
- [16] Dumais, S. A. (2002). Culture Capital, Gender, and School Success: The Role of Habitus. *Sociology of Education*, 75.
- [17] Iyer, S. Kitson, M. and Toh, B. (2005). Social Capital, Economic Growth and Regional Development. *Regional Studies*, 39.
- [18] Iyigun, F. A. (2000). Timing of Childbearing and Economic Growth, *Journal of Development Economics*, 61.
- [19] Reay, D. (2004). Education and Culture Capital: The Implication of Changing Trends in Education Policies. *Culture Trends*, 13.
- [20] Self, R. and Grabowski, R. (2003). Education and long-run development in apan. *Journal of Asian Economic*, 14.
- [21] Soubbotina, T. P. (2004). Beyond Economic Growth. Washington, D. C: World Bank.
- [22] Sullivan, A. (2001). Culture Capital and Education Attainment. *Sociology*, 35.



# Design a public swimming pool based on ecological perspective

H. Shoaee, S. Shahroody\*

**Abstract**—In this paper, a public swimming pool is designed with an ecological perspective, due to the energy crisis in the country, air pollution caused by the use of conventional fossil fuels and also the need for civil society in Iran especially in arid tropical area. Shahrood city has an excellent situation for the use of solar energy and the construction of a public swimming pool because of the special geographical position, locating in the border areas of desert and a lot of sunny days throughout the year. It is used the structure of several pools based on solar energy in different continents for the design of this swimming pool with considering the climate and ecosystem of Shahrood city. Some features like the use of solar energy for heating pool water cycle, education to promote respect for the environment for energy conservation, and reduce pollution in the pool for a tourist attraction addition to attraction for sport and recreation, can be noted for this design. Finally, with considering to the lack of ecological pool with this approach in Shahrood city and different advantages of it, providing the funding and implementation of it could have a major impact on various aspects of Shahroodian people life.

**Keywords**—swimming pool, environment, ecosystem, solar energy, ecological approach.

## I. INTRODUCTION

Pools are specific places where people involved in creating a feeling of happiness, a sense of community to strengthen and improve the quality of social and recreational life as well as the health of the community. Pools are locations to communicate between people and induce a sense of calm and joy and make the opportunity to have calming experiences in a modern urban living by create a space of recreation and sport. Designers and planners should investigate the different cultures of groups that use the city pools and consider their needs in their programs [1]. Usually low-income urban residents and immigrants have the lack of green space and pool due to the high population density in those areas. Pools

are usually made densely in populated urban areas that have relatively easy access to water resources. Their goal is to create a sport environment for all groups of society [3]. For example, Fajr pool in Shahrood city is located in a sparsely populated part of the city, whereas in areas with high population density such as Mahdi Abad and Kosar town with 35,000 inhabitants, there is not an appropriate pool.

Swimming pools are used for different applications and have different parts based on their application.

Public swimming pool consists of the following [10]:

- Pool Hall
- Swimming pool
- Jacuzzi
- Steam sauna
- Dry sauna
- Cold water pool
- Login
- Cloakroom
- Showers
- Toilets

For optimal performance of these parts require an integrated facility in order to provide a suitable environment for swimmers.

To estimate the requirements, integrated facilities are provided in the space named as a pool powerhouse. Powerhouses are equipped as follows:

- Spa boiler
- Steam boiler
- Softener
- Sand filter
- Heat exchanger

The pool powerhouse designing includes 3 parts:

- The first part: heating unit
- The second part: water purification
- The third part: pumping

Due to general nature and direct relation to the health of people, pools must have certain structural features in which safety and health care are fully considered.

Pool structural requirements briefly include:

- From the architectural point of view, the pool structure should:

Plans of pool must have a standard scale for length, width

Manuscript received December 1, 2014; Revised version received January 10, 2015. H. Shoaee is head of the department of engineering, Islamic azad university, shahrood branch, Shahrood, Semnan, Iran (e-mail: shoaei1393@gmail.com).

S. Shahroody, was MSc student in the department of engineering, Islamic azad university, shahrood branch, Shahrood, Semnan, Iran (corresponding author phone: +98-23-32229901; e-mail: Shahroody.sima1@gmail.com).

and depth of the pool [2].

Pool slope and thickness of pool walls and its concrete cover should precisely calculated [2].

Pool must be at least 10 meters away from the buildings connected to the residential part [4].

The bottom of the pool structure should have enough slopes to exit water. Pools for sport games should be standardized and specific rules are used in their construction [7].

Deck must exist around the pool to walk. The deck part should have a part for the waste [7].

Emergency equipment must be available and able to work inside the pool for immediate emergency and the pool should equipped with oxygen supply capsule [5].

A Head room must be above the pool diving board to control the pool. Air conditioning in the pool must exist. Layout and design of light should be such that personnel clearly see all parts of the pool such as diving boards and other walking places [7].

Places to walk around the pool should not be slipping individuals [7].

Pool safety map includes design data. This data is a report about slope of a reference pool; moreover a pool safety map is necessary for health protection [9].

From the facility perspective pool structure must:

Metal tubes and metal cables and hard metal parts including pool metal ladder is proved that all should be of stainless steel [6]

Sewage system should be enough for the pool showers and toilets and there should be no connection between Sewage system of pool showers and toilets and wastewater systems and each system should be separate [7].

Lamps should not create any danger in hot and humid weather of the pool. For underwater lighting, electrical flow must be passes less than 0.5 volt [7]. All piping must be in separate parts and underground of the pool. All pipes of the pool should superficies and weather pressure should be controlled [1].

Drinking water pipes and Pool supplies water pipes should not be connected or cross-linked [2]. Hoses should be of sufficient size and sufficient water and water suction flow should be available for all parts of the pool [7]. Use of the Sodium Hypo chloride in the pool causes that amount of Cl gas cannot be too high in the environment [8].

- Pool materials:

Pools must be constructed of white concrete or bright colors. Materials must be chemically safe. Materials must be cleaned up; usually these materials include concrete, stainless steel walls and concrete floors or fiberglass walls and concrete floors. Concrete may also be used in walls and wall panels [7].

Ladder into the pool must be made from good materials to clean easily [7].

All sections should be re-examined separately before

making a swimming pool [1].

According to the use of clean energy system in powerhouse heating unit which was mentioned at the beginning of the introduction, solar water heating system can be used in the designed public swimming pool simultaneously with the powerhouse facilities. The solar water heating act as pre heating system of powerhouse and in fact it warms the input water into the powerhouse as much as possible. If this amount of heat is not enough, powerhouse system is not operating and hot water pumps into the pool. Only in cases where the incoming water temperature is below the standard of hot water pool, powerhouse system is used to compensate for this deficiency and adjusting water temperature.

Solar water heating systems have several divisions as follows [11]:

- Direct
- Indirect

That these two categories are divided into two groups: active and passive.

In direct group sunlight directly provide hot water. In indirect group sunlight firstly shine on the surface of the solar collector and then transfer to the water by an interface system that includes a conductive heat fluid and make it warm.

In active systems, water circulation is a closed system and pump is used to remove fluid. While in passive systems, water and fluid displacement occurs naturally. But the system is not efficient in the pool due to the volume of pool water circulation and high demand of water circulation so that pump must be used.

The location of the collector installation is very important in solar water heater systems and must cover a large area and should be exposed to direct solar radiation.

According to the Shahrood climate and the space of pool roof and south wall of it, there is no problem from this opinion.

This paper aims to design a public pool with a solar water heater to save fossil energy consumption and help to preserve the ecosystem and environmental resources. This design attempts to consider native culture and climate simultaneously, to use modern technology besides native culture space appropriately.

## II. IMPLEMENTATION

Pool construction location was selected in the southern part of the Shahrood city due to the micro-climate situation, because there is more sunlight in this region than in other areas. In addition, the density of young population and the pool applicant are much better in the southern parts of the city. According to the preceding description different applications were considered for different age groups in the pool. A children's pool, dry and steam sauna and Jacuzzi has been seen in pool design.

According to the size of the pool, specific parking, a small cafeteria, a place for ticket sale, green space, several alcoves and platforms to sit in the green space at the pool site are considered. For use the sewage of different parts of pool service and not polluting the ecosystem, after passing the preliminary purification of natural water, is used for watering lawns. Warning signs are seen in the area of green space indicating the non-potable water.

In another part of the site specific greenhouse for ornamental exotic flowers that are interesting for visitors, and are vulnerable to cold, embedded to have special interest for users in the different seasons of the pool with a set of native plants and flowers in greenhouses. Purified water of pool service part is used for watering plants in this greenhouse.

A number of solar light collectors will be placed at the site adjacent to the route of users, so that the pool Visitors, can closely observe the solar system. This causes tourist attraction, in addition to familiarizing users with clean energies and how to use them in the pool water heating cycle. To create and provide clean energy for this set by solar panels design and produce enough electrical power for the pool we can provide electrical power requirements for lighting pool and service set of the site to an acceptable level on the canopies of alcoves and on the roof of service spaces such as cafeteria and etc. It is obviously that alternative power source or connection to public electricity network is essential for electricity supply during the night or partially cloudy sky.

So far, all the views have been designed based on the use of clean energy. From the social perspective and considering to the fact that today's society demands of their leisure time has changed, recreational and sporting centers should be designed on the basis of a modern society. An individual in a modern society needs to work, exercise, and rest in a relaxed atmosphere such as green space, pool and other physiological needs in daily life.

Given that most of the middle class urban people in the southern part of Shahrood towns need to have a codified plan for day or weekend fun, so the pool should be designed for middle class people in this area and the cost of the pool and its use must be lower and its cost must be justified for the people of the area.

Due to the using of solar water heating and photovoltaic cells and saving the cost of production and transportation of fossil fuels and electric power plants, the current cost of the pool is reduced and thus the cost from users will be significantly reduced other than public pools.

Sport and recreation are important in people life and the pool in an open green space raises their quality of life. Research shows that people who use the pool has high vitality and health.

It should be explained that since the creation of green spaces in the pool site help general vitality and due to attract

all age groups, this issue has been considered in the design of the pool.

It should be considered a part for management in public swimming pool design. This section is designed to management and regulation of sports and recreational programs and tournaments and monitoring the performance of the various facilities and services, it has tried to consider its centrality in order to dominate all parts. This section contains planning tasks for swimming competitions, special facilities for students or government agencies with special discounts at regular hours. Management of the pool should have continuous connection with different social groups for a more dynamic role in the pool.

### III. CONCLUSION

In this paper, a public swimming pool is designed with an ecological perspective. Several ecological structures in different continents of the world are used in the design of this pool and different climate of Iran (Shahrood city) and related countries to these pools are considered in the design. Some features of this design include creating a cycle of water recycling, natural water filtration system, public education and creating a culture of environmental preservation and respect for it, Saving fossil energy resources and reduce environmental pollution, and finally creating incentives to promote the replacement of solar water heaters instead of fossil fuels water heaters (especially gas) as a culture. Finally, a public Pool is designed with attractive visual elements and creating a sense of comfort for today's society of our country, taking into account the mental and physical needs of most users and due to the lack of a public pool with a such perspective in the province and several benefits aspects of the pool, funding and implementing of it could have a major impact on various aspects of life in the Shahroodian people or similar climatic zones in the country.

### IV. REFERENCES

- [1] Kilb, L.D., Esq. Come on In, The Water's Fine – But Only If You Can Get There. On line resource from Disability Rights Education & Defense Fund (DREDF), 2012.
- [2] Swimming Pool Equipment, Spas, Fountains and Hydromassage Bathtubs Marking and Application Guide. UL and the UL logo are trademarks of UL LLC, Regulatory Services Department, UL 333 Pflingsten Road, Northbrook, IL 60062, USA, 2012.
- [3] Swimming Pools, Spas and Bathhouses. The Code of DeKalb County, Georgia, Chapter 13, Article VIII, Sections 13-181 through 13-218. June 20, 2006.
- [4] Why Remove Your Swimming Pool. Apartment Management Magazine. 2008.
- [5] Equipotential Bonding of Permanently Installed Swimming Pools. ERICO International Corporation, 2007.
- [6] U.S. Consumer Product Safety Commission. Publication No. 359. Washington, DC 20207, USA.
- [7] Hideyuki Sanmiya, Improvement of Water Quality of Tachikawa Citizen Swimming Pool, Surprising Effectiveness and Performance of Mixed

**ISSN (Online): 2305-0225**

**Issue 16(4) [Supplementary Part IV], September 2014, pp. 1046-1049**

- Oxidant Generator Made in USA, Directing Manager of Tachikawa Gymnasium, November 2005.
- [8] Environmental Health Technical Brief. Indoor Air Pollution at Indoor Swimming Pools. Environmental & Occupational Health Assessment Program, Issue 5, April 2011.
  - [9] B.C. Guidelines for Pool Design Version 2, Ministry Of Health, Health Protection Branch, USA, June 2014.
  - [10] LATICRETE Technical Services, Tiled Swimming Pools, Fountains, and Spas Technical Design Manual, Kindle Edition, LATICRETE International, Inc. 2009.
  - [11] Know More about Solar Water Heating System, E&M Safety and Energy Efficiency office, Electrical and Mechanical Services Department Headquarters, 3 Kai Shing Street, Kowloon, Hong Kong, 2013.
  - [12] Solar water heating systems – guidance for professionals, conventional indirect models, Energy Saving Trust, 21 Dartmouth Street, London SW1H 9BP, UK, March 2006.
  - [13] A Consumer's Guide: Heat Your Water with the Sun, National Renewable Energy Laboratory, 901 D. Street, S.W. Suite 930, Washington, D.C. 20024-2157, USA, 2003.

# Forage yield stability *in* populations of *Agropyron cristatum* using parametric stability methods

Tahereh Jalili Zalpour<sup>1</sup>, \*Ali Ashraf Jafari<sup>2</sup> and Khodadad Mostafavi<sup>3</sup>

<sup>1</sup> MSc Graduated in Plant Breeding, College of Agriculture & Natural Resources Islamic Azad University, Karaj Branch, Karaj- Iran

<sup>2</sup> Prof. in Plant Breeding, Research Institute of Forests and Rangelands, Tehran, Iran, \*Corresponding Author: Email: [aajafari@rifr-ac.ir](mailto:aajafari@rifr-ac.ir)

<sup>3</sup> Assist. Prof. Department of Plant Breeding, College of Agriculture & Natural Resources Islamic Azad University, Karaj Branch, Karaj- Iran

**Abstract**— The Forage Dry matter (DM) yield were investigated for 18 accessions of *Agropyron cristatum* in an experimental based on randomized complete block design with three replication at two environmental conditions (rainfed and irrigated) in three research station as Mashhad, Brojerd and Karaj, Iran. The stability parameters of coefficient of variation ( $CV_i$ ), Shukla's stability variance ( $\delta^2_i$ ), Wricke's ecovalance ( $W_i^2$ ), Deviation from regression ( $S^2d_i$ ), Eberhart/Russell regression coefficient ( $b_i$ ) and coefficient of determination ( $R_i^2$ ) were estimated for all of accessions. According to Eberhart and Russel (1966) method the accessions G5, G10 and G11 with slope of 1.0 with low deviation from regression coupled with higher DM yield over six environments considered as more stable. Accessions G1 and G9 had ( $b_i < 1$ ) and higher DM yield for poor environment. The Accessions G13, G15 and G18 showed ( $b_i > 1$ ) and indicate sensitivity to environmental changes for DM yield. To better understand the relationships among the parametric stability statistics and assessment of stable accessions, principal component analysis (PCA) was used. The results of (PCA) showed that the two first components explained 48.58% and 38.31% of total variation. The accessions of G11, G18, G12, G10 and G7 were superior based on all stability parameters and the accessions of G17, G15 and G13 were stable based on  $CV_i$ ,  $W_i^2$  and  $S^2d_i$  and had a high yield. The accessions of G1, G3, G5, G8 and G4 were classified as stable accessions based on  $\delta^2_i$ ,  $b_i$  and  $R_i^2$  and this group had a low mean yield. The accessions of G16, G2, G9, G14 and G6 had a week stability and DM yield based on all calculated parameters and means of DM yield.

**Keywords**— Forage yield, parametric stability, *Agropyron cristatum*

## INTRODUCTION

*Agropyron* Genus is known as tolerant to drought, low temperature and salinity, and resistant to the rusts and other pathogens of wheat (*Triticum aestivum* L.), which can be valuable resources in wheat improvement [1]. *Agropyron* is a cool-season bunchgrass from southern Europe and Asia [2].and has a wide adaptability to conditions of humidity, temperature and altitude [3].

The stability parameters of coefficient of variation ( $CV_i$ ), Shukla's stability variance ( $\delta^2_i$ ), Wricke's ecovalance ( $W_i^2$ ), Deviation from regression ( $S^2d_i$ ), Eberhart/Russell regression coefficient ( $b_i$ ) and coefficient of determination ( $R_i^2$ ) are used to estimate stability of genotypes.

According to the joint linear regression model which was developed by Finlay and Wilkinson [4] and modified by Eberhart and Russell [5]. A stable variety is one with a high mean yield, regression coefficient equals to one ( $b_i = 1$ ) and deviation from regression equals to zero ( $S^2d_i = 0$ ) [5]. In this method, the sum of squares due to environments and genotype x environment are partitioned into environments (linear), genotype x environment (linear) and the pooled deviations from the regression model. If the variation among the genotypes and for G x E interaction were significant, it means that genotypes exhibited different performance in different locations/environments which is due to their different genetic makeup or the variation due to the environments or both.

Wricke proposed using the contribution of each genotype to the G x E interaction sum of squares as a stability measure and defined this concept or statistics as ecovalance ( $W_i^2$ ) [6].

Genotypes with a low  $W_i^2$  value have smaller deviations from the overall mean across environments and are thus more stable. According to Becker and Léon ecovalence measures the contribution of a genotype to the G x E interaction; a genotype with zero ecovalence is regarded as stable [7].

Shukla's stability variance ( $\delta_i^2$ ), [8] is a modified version of the ecovalence in order to give unbiased estimate of the G x E variance for every genotype using the stability variance. A genotype is called stable if its stability variance is equal to the environmental variance which means that stability variance equal to zero. A relatively large value of stability variance will thus indicate greater instability of genotype.

The objectives of this study were to evaluate forage yield performance and stability of 18 accessions of *Agropyron cristatum* using parametric method to identify accessions that are widely adapted (stable) and specifically adapted (with narrow adaptation) for DM yield.

## MATERIALS AND METHODS

Performance stability of 18 accessions of *Agropyron cristatum* species was evaluated using randomized complete block design with three replications under two different environments (irrigated and rainfed) at the three research station contains; Mashhad, Brojerd and Karaj, Iran. The climate Brojerd is moderate semiarid with annual precipitation above 400 mm. The climate of Mashhad and Karaj is cold semi arid with annual precipitation between 250-350 mm. The drought period of three stations is four months of year and wet season starts in October and it continued until May [9].

The 18 accessions of *Agropyron cristatum* (originated from different parts of Iran) were provided from natural resources gene bank (Research Institute of Forests and Rangelands, Iran) (Table 1). The seeds were sown as 15 kg $^{-1}$  in four drilled lines as long as 2m with 25cm distance in sward condition using randomized complete block design with three replications in autumn 2009. In Irrigated experiments the irrigation was made according to the plant requirement, but for rainfed condition no irrigation were made. Weeds were control mechanically and fertilizing schedule was made based on scientific advices and recommendations. In establishment year, plots were cut once, but no data were measured. In 2010 and 2011 plots were cut for two times for DM yield. Then, the total annual DM yield was averaged over two years and consequently were used for combined analysis over six environments.

Based on Eberhart/Russell stability regression model, the regression coefficient values ( $b_i$ ) and deviation from regression ( $S^2d_i$ ) were calculated for each of the 18 populations. A stable populations with a high mean yield, regression coefficient equals to one ( $b_i=1$ ) and deviation from regression equals to zero ( $S^2d_i=0$ ) were identified [5]. Deviation from regression ( $S^2d_i$ ), were calculated for studied accessions [4].

Ecovalence ( $W_i^2$ ), were calculated for each of the 18 populations [6]. Genotypes with a low  $W_i^2$  value have smaller deviations from the overall mean across environments and are thus more stable. Shukla's stability variance ( $\delta_i^2$ ), were estimates of an entry's variance across environments [8]. Stable populations have smaller estimates. Each variety that has less coefficient of variation ( $CV_i$ ) is more stable. The main problem in this method is that more stable varieties have low yielding. Pintus suggested that because the coefficient of determination ( $R_i^2$ ) is highly dependent on  $S^2d_i$ , therefore, Instead of the mean square deviation is better than be used of the regression coefficient of determination [10]. The stability parameters were performed using Agrobase [11]

Table 1. Gen bank names, code and origin of accessions of *Agropyron cristatum*.

Code	Name	Origin	Code	Name	Origin
G1	1722m	Gorgan	G10	P <sub>2</sub> 208	Karaj
G2	1727m	Gorgan	G11	208s	Karaj
G3	P <sub>10</sub> 172	Gorgan	G12	4056m	Isfahan
G4	P <sub>12</sub> 172	Gorgan	G13	P <sub>1</sub> 405	Isfahan
G5	P <sub>7</sub> 1727	Gorgan	G14	P <sub>2</sub> 405	Isfahan
G6	208m	Karaj	G15	529m	Hovare
G7	P <sub>10</sub> 208	Karaj	G16	619m	Isfahan
G8	P <sub>13</sub> 208	Karaj	G17	P <sub>13</sub> 619	Isfahan
G9	P <sub>2</sub> 208	Karaj	G18	619s	Isfahan

## RESULTS AND DISCUSSION

The stability parameters of coefficient of variation ( $CV_i$ ), Shukla's stability variance ( $\delta_i^2$ ), Wricke's ecovalence ( $W_i^2$ ), Deviation from regression ( $S^2d_i$ ), regression coefficients ( $b_i$ ) and coefficient of determination ( $R_i^2$ ) were calculated based on yield from six environments (Table 2). The accessions showed different performance based on different stability parameters and some of the accessions based on some parameters had high stability, and based on other parameters, had a poor stability.

According to Finlay and Wilkinson [4] and Eberhart and Russell [5] a stable variety is one with a higher mean DM yield, regression coefficient equals to one ( $b_i=1$ ) and deviation from regression equals to zero ( $S^2d_i=0$ ). These genotypes have average stability and are well or poorly adaptable to the all environments depending on high or low mean performance. The relationship between the regression coefficients ( $b_i$ ) and mean DM yield for 18 genotypes (Table 2) were plotted (Fig. 1). The stable populations would therefore be those whose slope was 1.0 and the deviation from the regression ( $S^2d_i$ ) close to zero (Table 2). According to Eberhart and Russel method the populations G5, G10 and G11 with slope of 1.0 with low deviation from regression coupled with higher DM yield over six environments considered as more stable [5]. A genotype with ( $b_i<1$ ) has above average stability and is

especially adaptable to low-performing environments. Accessions G1 and G9 had ( $b_i < 1$ ) and higher DM yield for poor environment. Accessions with ( $b_i > 1$ ) have below average stability and is especially adaptable to high performing environments. The Accessions G13, G15 and G18 showed ( $b_i > 1$ ) and indicate sensitivity to environmental changes for DM yield (Table 2 and Fig. 1).

To better understand the relationships among the parametric stability statistics and assessment of stable accessions, principal component analysis (PCA) was used. The results of PCA (Table 3) showed that the two first components were explained 48.58% and 38.31% of variance and in total 86.89% of variance was explained by these two components. The statistics of  $b_i$  and  $\delta_i^2$  had positive values and  $R_i^2$  had negative in the first component.

The statistics of  $CV_i$ ,  $W_i^2$ ,  $S^2d_i$  and DM yield had higher values for the second component. Biplot of the first two components (Fig. 2) were scattered based on PCA analysis for DM yield of 18 accessions of *Agropyron cristatum*. The statistics of  $b_i$  and  $\delta_i^2$  had a similar reaction in stability evaluation of accessions and the statistic of  $W_i^2$  and DM yield had a similar reaction in stability evaluation of accessions. The statistics of  $b_i$ ,  $\delta_i^2$ ,  $W_i^2$  and DM yield considering to low angle between their vectors and they had a similar performance in stability evaluation of accessions. On the other hand, the statistics of  $S^2d_i$  and  $CV_i$  had a similar performance in stability evaluation of accessions and the statistic of  $R_i^2$  had a different performance in stability evaluation of accessions with other statistics, which considering to location of its vector in biplot can be said that had a similar performance with  $S^2d_i$  and  $CV_i$ . Based on biplot analysis,, the accessions of G11, G18, G12, G10 and G7 can be introduced as the stable accessions based on all parameters. The accessions of G17, G15 and G13 were stable based on  $CV_i$ ,  $W_i^2$  and  $S^2d_i$ ; also, this group had a high mean yield. The accessions of G1, G3, G5, G8 and G4 were stable based on  $\delta_i^2$ ,  $b_i$  and  $R_i^2$  that this group had a low mean yield. The accessions of G16, G2, G9, G14 and G6 based on all statistics and mean yield had the lowest performance.

Table 2. The stability parameters for forge DM yield of 18 accessions of *Agropyron cristatum*

Genotype code	$Y_{i0}$	$b_i$	$CV_i$	$W_i^2$	$\delta_i^2$	$S^2d_i$	$R_i^2$
G1	959	0.79	0.27	62074	40611	67640	0.13
G2	536	0.53	0.23	82156	207006	50966	0.50
G3	881	1.14	0.27	60600	19821	70795	0.07
G4	725	0.81	0.57	252942	24914	208699	0.03
G5	957	0.99	0.29	64026	156	30006	0.00
G6	918	1.62	0.23	74799	171555	50610	0.66
G7	882	1.19	0.22	43211	33278	45669	0.15
G8	827	1.02	0.21	76050	1125	92282	0.00
G9	852	0.73	0.32	90391	70212	95610	0.16
G10	994	1.00	0.27	57173	11	71482	0.00
G11	954	1.05	0.12	11409	2524	12623	0.04
G12	816	0.82	0.21	40528	28045	42656	0.14
G13	1050	1.59	0.12	77201	220788	12804	0.86
G14	907	1.26	0.25	60958	61823	60761	0.20
G15	1022	1.25	0.14	27496	59128	19588	0.43
G16	718	0.60	0.19	96281	242424	24695	0.71
G17	860	0.84	0.16	26129	25709	22724	0.21
G18	1042	1.15	0.17	27098	20682	28726	0.15

$Y_{i0}$  = Mean of forge DM yield

$b_i$  = Eberhart/Russell regression coefficient

$CV_i$  = coefficient of variation

$W_i^2$  = Wricke Ecovalence

$\delta_i^2$  = Shukla's stability variance

$S^2d_i$  = Deviation from regression

$R_i^2$  = coefficient of determination

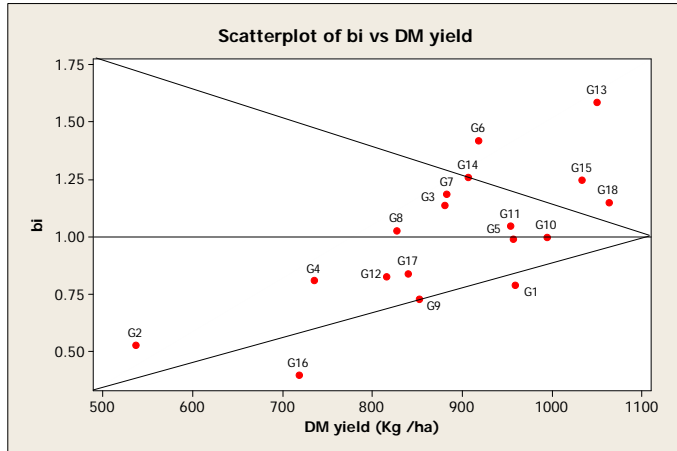


Fig. 1. The regression coefficients plotted against genotypic mean, adapted from Finlay and Wilkinson [4]

Table 3. Eigenvalue, percentage of variance, cumulative variance, the first two component

Statistics	PCA 1	PCA2
Regression coefficients ( $b_i$ )	<b><u>0.920</u></b>	0.357
Shukla's stability variance ( $\delta_i^2$ )	<b><u>0.920</u></b>	0.357
Coefficient of determination ( $R_i^2$ )	<b><u>-0.971</u></b>	0.025
DM yield	0.084	<b><u>0.625</u></b>
Coefficient of variation ( $CV_i$ )	-0.595	<b><u>0.779</u></b>
Wricke's ecovalance ( $W_i^2$ )	0.261	<b><u>0.900</u></b>
Deviation from regression ( $S^2d_i$ )	-0.580	<b><u>0.786</u></b>
Eigenvalue	3.400	2.682
Percent of Variance	48.58	38.31
Cumulative variance	48.58	86.89

The bold and underlined data has higher values in components

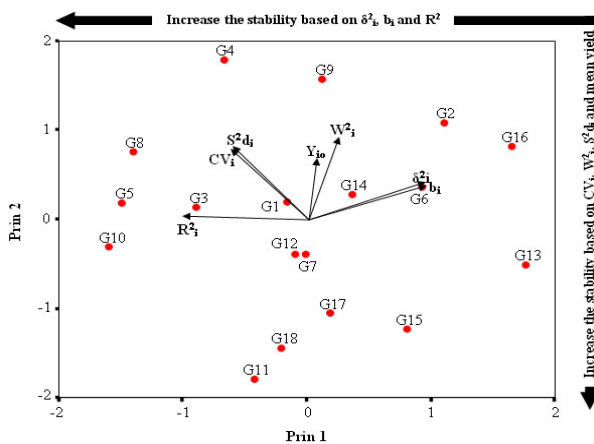


Fig 2. Biplot of parametric statistics based on two first components value for accessions

G<sub>1</sub> to G<sub>18</sub> = Accessions code as presented in Table1  
 $b_i$  = Regression coefficients  
 $\delta_i^2$  = Shukla's stability variance  
 $R_i^2$  = Coefficient of determination  
 $Y_i$  = DM yield  
 $CV_i$  = Coefficient of variation  
 $W_i^2$  = Wricke's ecovalance  
 $S^2d_i$  = Deviation from regress

REFERENCES

- [1] Che, Y. H. and Li, L. H., 2007. Genetic diversity of prolamines in *Agropyron mongolicum* Keng indigenous to northern China. *Genet Resour Crop Evol* 54: 1145–1151.
- [2] Vogel, K. P. and Moore, K. J., 1998. Forage yield and quality of tall wheatgrass accessions in the USDA germplasm collection. *Crop Science* 38: 509-512.
- [3] Daniel, G. O., Loren, S. J. and Kevin, B. J., 2003. Intermediate Wheatgrass (*Thinopyrum intermedium* (Host) Barkworth & Dewey, D. R.). In: Plant Guide. United States Department of Agriculture.
- [4] Finlay, K. W. and Wilkinson, G. N., 1963. The analysis of adaptation in a plant breeding program. *Aust. J. Agric. Res.* 14: 742-754.
- [5] Eberhart, S. A. and Russell, W. A. 1966. Stability parameters for comparing varieties. *Crop Sci.* 6:36-40.
- [6] Wricke, G. 1962. ber eine methode zur erfassung der ökologischen Streubreite in feldversuchen. *Z. Pflanzenzüchtg.* 47: 92-96.
- [7] Becker, H.C. and Léon, J. 1988. Stability analysis in plant breeding. *Plant Breeding* 101: 1-23.
- [8] Shukla, G. K., 1972: Some statistical aspect of genotype-environment components of variability. *Heredity* 29: 237-245.
- [9] Badripour, H., N., Eskandari, and S. A. Rezaei 2006. "Rangelands of Iran, an Overview". Ministry of Jihad-e-Agriculture, Forest Range and Watershed Management Organization, Technical Office of Rangeland, Tehran, Iran, (<http://www.fao.org/ag/AGP/AGPC/doc/Counprof/Iran/Iran.htm>).
- [10] Pinthus, M. J., 1973. Estimate of genotype-value: A proposed method. *Euphytica* 22: 121-123.
- [11] Agronomix Software Inc. 2000. Agrobases User's manual. Winnipeg, Manitoba, Canada.



# Determination Heavy metals Accumulation in Water, Sediment and Fish of Qarasou River

Hassan Gasempour Niari<sup>1</sup>, Ebrahim Fataei<sup>2</sup>, Reza Aghayari samian<sup>3</sup>, Mehdi Aalipour erdi

1. Msc of environmental engineering, Environment pollutions, Islamic Azad University, Ardabil branch, Iran(ozonardabil@yahoo.com)
2. Environmental Engineering Department, Ardabil Branch, Islamic Azad University, Ardabil, Iran(ebfataei@gmail.com)
3. Geographic Department, Azad University Ardabil Branch, Iran(danial8538@gmail.com)
4. Msc of Environmental planning and management, Graduated faculty of Environment, University of Tehran, Iran(maalipour@ut.ac.ir)

**Abstract**— The excessive increasing of population and industrializing societies, especially since second half of the 20th century, is caused to appearing new problems about environment pollutions. Heavy metals are some kinds of these pollutions that they are naturally marine ecosystems constituents. Even some of them have a crucial role in the living creatures' existence, but their too much density causes the endangering of the aquatic creatures' life. In this investigation, four stations were determined in order to determining the amount of heavy metals including Cu, Ph, Cd, Fe, Zn, and Ni in Qarasou River's water, sediment and fish. Furthermore, physiochemical parameters (water temperature, dissolved oxygen, total hardness, electronic conduct, SIO<sub>2</sub>, TP, TN, PO<sub>4</sub>, NO<sub>3</sub>, NO<sub>2</sub>, NH<sub>4</sub>, TDS, COD, BOD<sub>5</sub>, and PH) were measured. The results showed that the observed heavy metals in the water of the region relate to Zn, Fe, Cu, and Ni. In the sediments of basin Pb, Zn, Fe, Cu and Ni were seen and the heavy metals such as Zn, Fe, and Cu in the tissue of fish Squalies Cephalus type and Pb, Zn, and Cu in Copeata type were observed. Based on the observations of metals in water, sediment and the tissue of fish, there are Cu, Zn, and Fe in the form of bioaccumulation in the tissue of the fish. The observed results indicated that non biological parameters including Nitrite, Phosphate, total Phosphorous, TDS, COD, Zn, and Fe amount aren't in complete desirable circumstances and some parameters like BOD<sub>5</sub>, however they are in normal boundary, their amount is comparatively high.

**Keywords**— Bioaccumulation, heavy metals, water, sediment and fish.

## I. INTRODUCTION

UNFORTUNATELY quick increase of population and development of residential, commercial, industrial and agricultural centers cause the increase in urban garbage and wastes yearly and pollution of the human and aquatic environment [1, 8].

The aquatic products pollution to the heavy metals is one of the significant points. Because the heavy metals are stable pollutions that don't decompose in nature via chemical and

biological processes contrary to organic compounds. One of the important results of the heavy metals stability is wide biological extent in the food chain as the result of this process, their amount can increase many time as much as the amount of the metals found in water or air in the food chain [5]. The heavy metals are considered as dangerous polluters as the result of stability and their bioaccumulation in the natural environment [12,7]. The heavy metals make some problems by bioaccumulation in the living creatures for long periods [9]. These polluters, considered as stable polluters, can raise to the higher ranks of food chain by biological magnification [13,9]. More attentions are paid to water resources for the human's need for food in the last years. The aquatic creatures which are the human's food resource, cumulate the evacuated heavy chemical elements in the waters in their body, in other words they condense these elements (Bioaccumulation) and transfer them to the higher levels and finally to the human's body [6]. The rivers sediment is the main place of obtaining and storing the polluters in marine environments and it has an important role in accumulating some heavy metals in the foam living invertebrates and raising them to the higher food levels. Totally it can be said the sediments are as the crucial introducer for the pollution which the pollution and the kind of pollution can be easily determined by analyzing and studying them and take a decision for their control [2,6]. The sediments are the final place of the heavy metals accumulation in the aquatic environment, but they can perform as a pollution resource under some conditions [3,15]. Now the pollutions of environment arising from the heavy metals are counted as a global problem [3,14]. Industrial developments in addition to have some advantages, cause to appear some problems like intense pollution of ecosystem caused to the environment destruction and the threat of aquatic creatures' life [4,10].

## II. MATERIALS AND METHODS

### - Case study

Ardabil province is located in the northwest of Iran plateau including about 1.09% of total area of Iran with an area far more than 17953 squared km. Ardabil province is counted a relatively high plateau surrounded by high mountains. Low and relatively even lands are placed immediately after mentioned heights. The average of Ardabil province height is 1400 meter above the sea level. The lowest internal locality is in Parsabad and Bilesavar with the height less than 100m. The natural appearance of Ardabil province differs from other regions of Azerbaijan plateau. The low and plain lands, which have the height less than 100m, make the northern lands and neighbor with Azerbaijan Republic along Aras River. Meshginshahr town is placed on northwest of Iran and in the distance of 90km of Ardabil province's center. The climate of this town is mountainous mild. The temperature varies between -30 and +30 centigrade along the year. The famous Sabalan Mountain is placed at a distance of 25km from this town. The area of this town is about 3900km. The basin of Qarasou River is spread from 48°, 32'to47°, 28' of eastern longitude and 38°,15'to 39°,29' of north. This river creates the main amount of Meshginshahr, Ardabil and khalkhal waters such as Gourichai and Balikhlochai. It is the only natural drain of Ardabil plain that leaves the plain in Taleb Geshlgi village and flow sin north direction after passing Meshginshahr along Qarasou River and joining to the Aharchai in DoustBeiglou region. Qarasou River pours to the border river of Aras lower part of Aslandouz Bridge.

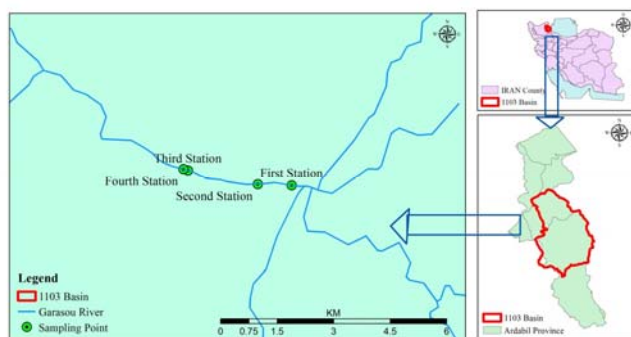


Fig1: The Location of the study area

## III. - METHODOLOGY

The necessary conditions (accessibility in the different seasons of year and different climate, the appropriate distances of stations toward each other and coverage the whole region) were taken into account in choosing the sampling station. The water taking places and water waste evacuation were some of the most important cases in choosing the stations.

Totally the water sampling was done monthly and sediment and fish sampling was done seasonal. The water sampling methods were performed using (ISIRI 2347) and (APHA, 2005) standards. The sampling vessels were polyethylene and the sampling was done from the surface of the water. The vessels were washed by nitric acid and the sampling was prepared by attaching a code. The sediment sampling was done by Grab sampler with the level of 20\*25 squared cm. The fishing was done by Electro fishing machine and then biometry was performed. Fresh fish was used for determining the heavy metals amount in the tissue of fish. The water heavy metals measurement was read after leading the water through Membrane filter (45micron) by the method of digesting nitric acid (E3030 method) and injecting to the atomic attraction machine (APHA, 2005). The measured parameters included: temperature, pH, dissolved oxygen, BOD5, COD, silica (SiO<sub>2</sub>) and azote (nitrite and ammonia), phosphorus (phosphate and total phosphate). Dissolved oxygen, COD and BOD5 were gathered in one liter plastic vessels by using Vinkler and other samples and then samples' specifications such as date and place of the sampling was wrote on the vessel and it was sent for measurement to the laboratory. The water temperature was measured by German reversible thermometers possessing the cover and an ordinary thermometer and also Japanese reversible thermometers (The sensitivity of German thermometer in one -hundredth and the sensitivity of Japanese thermometer is one-tenth). Nitrite (-NO<sub>2</sub>) was measured by Bern Snider and Rabinson method. Nitrate ion made color complex by adding sulphanyl amid and (fenil- N-1) ethilen diamid dihydrochloride that its attraction amount was read in wave-length of 543. The heavy metals measurements in the sediment and eatable tissue of fish was read by acid complex digesting and injecting to the atomic attraction machine (MOOPAM,1999).The muscular part of the fish separated from the other parts by Sculple blade for preparing the sample of fish after separating its skin. Then, it was dried using the Avan machine (ATYEH TEB AZMACO) in 103°C. The sediment samples were dried using of Avan machine after powdering and mixing in 105°C and they prepared for analysis. The measuring metals including Cu, Pb, Cd, Fe, Zn and Ni were measured in water, sediment and fish by using the atomic attraction equipped by three systems: flame, graphite and steam system with D2 ground lamp, THERMO, ELECTRON CORPORATION AA, SPECTROMETERM SERIES. BAE method will be used for determining the bioaccumulation using of the following formula:

BAE:  $C_{\text{organism}}/C_{\text{sediment}}$  in which  $C_{\text{organism}}$  indicates the density of metals in fish and  $C_{\text{sediment}}$  indicates the density of metals in sediment.

## IV. RESULTS

- The heavy metal analysis of water resources, sediment and fish

The amount of the heavy metals in water resources, sediment and fish was determined. The water sampling was

done monthly and sediment and fish sampling was done seasonally in the different stations and the results are as following :

Table 1: The results of the water heavy metals analysis /unit: mg/l

<i>Ni</i>	<i>Cu</i>	<i>Fe</i>	<i>Zn</i>	<i>Pb</i>	<i>Cd</i>	<i>Date</i>	<i>Station number</i>	
ND	0.006	0.228	0.010	ND	ND	August	1	1
ND	0.004	0.275	0.242	ND	ND	August	2	2
ND	ND	0.124	0.056	ND	ND	August	4	3
ND	0.004	0.455	ND	ND	ND	September	1	4
ND	0.018	0.535	ND	ND	ND	September	2	5
ND	0.003	1.075	0.10	ND	ND	September	4	6
ND	0.016	ND	ND	ND	ND	November	1	7
ND	ND	ND	ND	ND	ND	November	2	8
ND	ND	ND	0.03	ND	ND	November	4	9
ND	0.016	ND	ND	ND	ND	January	1	10
0.014	ND	ND	ND	ND	ND	January	2	11
ND	ND	0.216	ND	ND	ND	January	4	12

Table 2: The machinery analysis results of the sediments heavy metals / unit: mg/ kg

<i>Ni</i>	<i>Cu</i>	<i>Fe</i>	<i>Zn</i>	<i>Cd</i>	<i>Pb</i>	<i>Station number</i>	
13.3	65.3	15.336	46.3	ND	9.0	2	1
11.3	62.0	20.598	40.0	ND	ND	3	2
9.2	52.7	20.413	40.2	ND	3.5	4	3

Table 3: The results of the eatable tissue of fish analysis /unit: mg/kg

<i>Ni</i>	<i>Cu</i>	<i>Cd</i>	<i>Fe</i>	<i>Zn</i>	<i>Pb</i>	Weight (gr)	Total length (cm)	Species	Station
ND	3.0	ND	12.2	39.7	ND	28	18.8	<i>Squalius</i> <i>Cephaliscus</i>	2
ND	4.2	ND	5.8	22.2	ND	19.4	15.6	<i>Squalius</i> <i>Cephaliscus</i>	2
ND	2.8	ND	2.5	29.7	ND	17	14.9	<i>Squalius</i> <i>Cephaliscus</i>	2
ND	2.0	ND	4.0	44.7	ND	11.8	13.6	<i>Squalius</i> <i>Cephaliscus</i>	2
ND	2.3	ND	3.5	7.3	0.3	171	30	<i>Capoeta capoeta</i>	2
ND	ND	ND	ND	7.5	0.5	141.1	22.1	<i>Capoeta capoeta</i>	4
ND	2.0	ND	3.3	22.0	1.7	82.4	19.2	<i>Capoeta capoeta</i>	4
ND	ND	ND	12.3	20.7	ND	79.5	19.3	<i>Capoeta capoeta</i>	4
ND	ND	ND	12.5	11.0	1.8	22.7	18.3	<i>Capoeta capoeta</i>	4

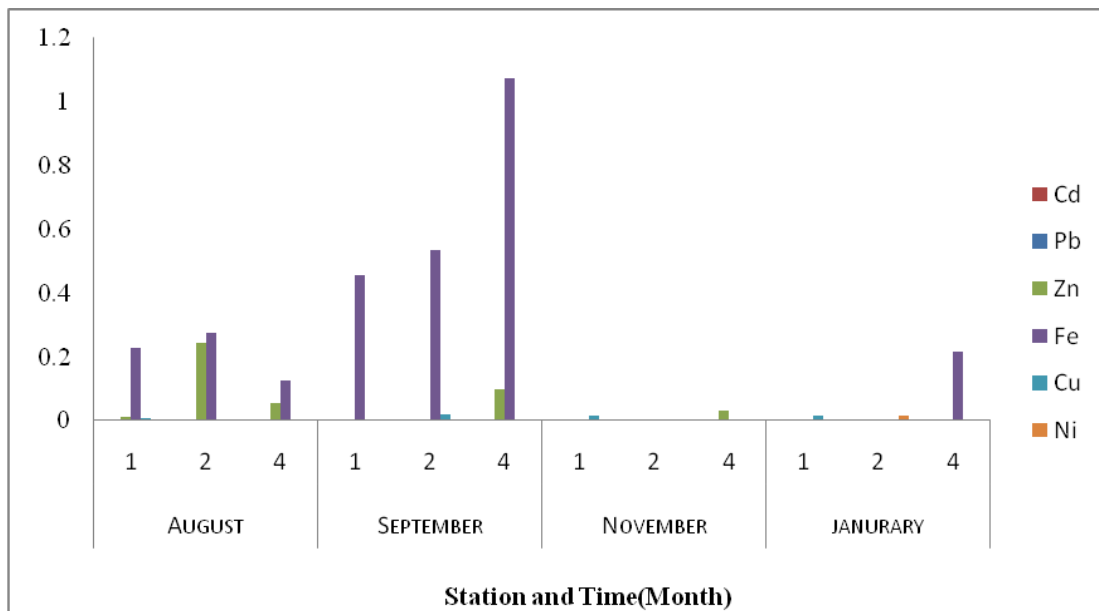


Fig 2: The analysis of water heavy metals

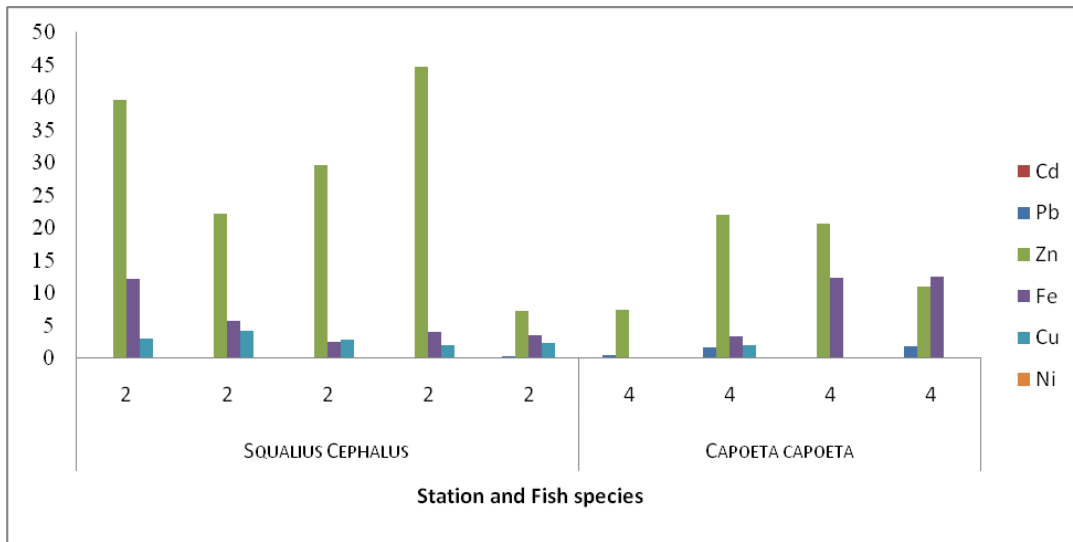


Fig 3: The result of heavy metals in tissue of fish's analysis.

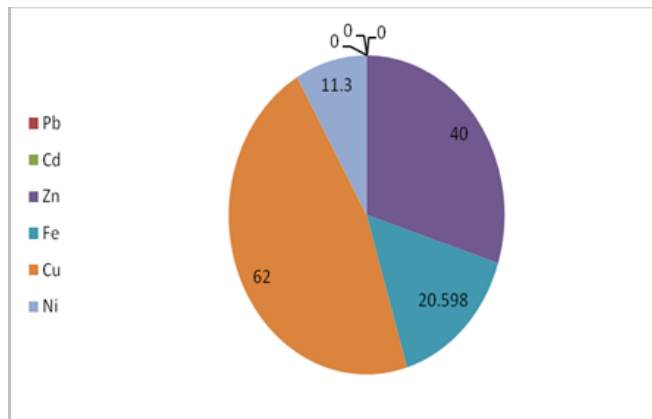
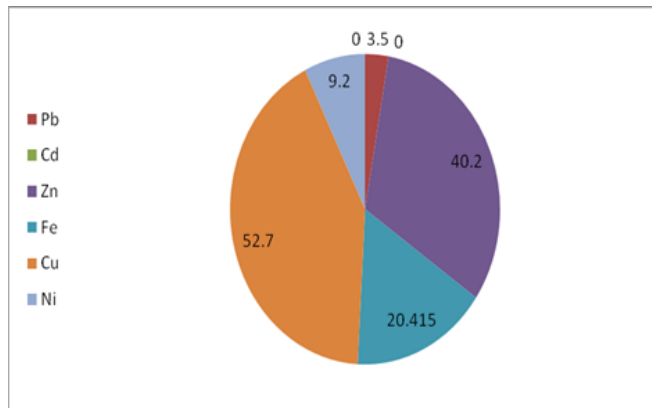


Fig 4: The amount of heavy metals in sediments

## V. CONCLUSION AND DISCUSSION

The pollution and problems' amount is increased after the Industrial Revolution and with increasing of daily global technology's level. Global ecosystems including land and marine were influenced by these processes and the increase of pollution. As, they caused to develop an attitude toward the environment, investigation and surveying the effects of different activities effects in 70 decade of 20th century. The entrance of metal polluters with human source to the marine environments is increased and this increase makes serious dangers to the life of marine ecosystems. The heavy metals are the examples of these materials that cause to produce the polluters and environmental problems. These metals cause some problems by bioaccumulation in the living creatures for long periods. The analysis of the heavy metals' amount of Qarasou River water, sediment and tissue of fish was investigated in this study. Four stations were determined in the region and the related cases were including: Ni, Zn, Fe, Cd, Pb, Cu and also some physiochemical parameters. The results indicated:

The most heat temperature is about 22° c in station 4 and the least temperature is -1° c in station 3. The least dissolve oxygen is about 7.6mg/l in the stations that shows the appropriate ecologic conditions in the regions. Also the biological and chemical oxygen needing increases by going far from station 1 to station 4. The observed heavy metals in the water of the region relate to Zn, Fe, Cu and Ni. Pb, Zn, Fe, Cu and Ni were seen in the sediments, Zn, Fe and Cu in the river whitefish type (C.s) and Pb, Zn, Cu and Fe in black fish type (C.c).

The obtained results in the present investigation indicated that some of the non biological parameters including nitrite, phosphate, total phosphorous, TDS, COD, Zn and Fe amount aren't in complete desirable conditions. However some parameters like BOD5 were in normal boundary, but their amount was measured rather high.

The results of water physiological specifications and biological indexes specify clearly the water quality especially organic materials accumulation in the river ecosystem in the studying region. According to the bioaccumulation results, the amount of Zn and Cu is more than both from water to the tissue of fish and from sediment to the tissue of fish and these metals maybe enter to the food chain in the next steps and cause to injure the other creatures.

## VI. REFERENCES

- [1] Scash. M.R, F.A.O, Pollution, "A global issue in the fishing industry (Fisheries Company press)," 1992, PP.18-21.
- [2] Imandel. K, "The investigation of granulating of organic materials and the determination of the heavy metals accumulation in the sediment of Chalous River (Environment science and technology journal)," spring issue, 1999, PP.13-18.
- [3] Bageri, H. and colleagues, "Measuring and evaluating the heavy metals pollution in the sediment of Gorgan Roud River, (Oceanography, second year, No5, spring)," 2011, PP.35-39.
- [4] Heidari. A. and colleagues, "Measurement and compare of the effects of some heavy metals in muscle and lung of Liza fish and its relation with length and weight, (First international trans-meeting of ecology crisis, Kish)," 2012.
- [5] Khodabandeh. S. "Accumulation of the heavy, metals in the sediments and the aquatic creatures of Caspian sea, Water and Waste, May 2000, No39, 19-20 and 38-42.
- [6] Kheirvar. N, Alidadolahi. S, "The density of the heavy metals in the sediment and Barbus grypus fish in Arvandroud, (Environment science and technology)," 12th volume, No2, The summer of 2010, PP. 123-131.
- [7] Davari. A, and colleagues, "The investigation of the heavy metals accumulation in the basin, leaf and the route of Hara trees in Boushehr province, The natural environment publication, Natural resources of Iran journal," 63volume, No3, autumn of 2010, PP.267-277.
- [8] Shahriari. A, "Measuring the amount of heavy metals like Cd, Cr, Pb, and Ni in the eatable tissue of the salted and red fish in Persian Gulf in 2003, (Scientific journal of Medical University of Gorgan)," 7th volume, No2, autumn and winter of 2005, pp.65-67.
- [9] Azimi. A, and colleagues, "Bioaccumulation of Hg, Cd, Pb and Cu in Crassostrea gigas in Imam Khomeini port, (Marine sciences and arts), 10 volume," No3, autumn of 2011, pp. 22-32.
- [10] Canli and Alti. "The relationship between heavy metals dissolved in sea Water and influences of Sex and size on Mcus. etal accumulation and Tissue distribution in the Norway Lob ster Nephrops norvegicus. Mar. environ," Res. 36, 2003, PP. 217-236.
- [11] MacFarlane. G.R. "Leaf biochemical parameters in Avicennia marina (Forsk.) Vierh as potential biomarkers of heavy metals stress in estuarine ecosystems." Marine Pollution Bulletin 44: 244-256.23.Kates, R.W.Paris. T.M. and leiserowitz, A.A.2005. What is sustainable development? Gols, indicators, valus, and practice. Environment, 2002, 47: 10-21.
- [12] Mance G. "Pollution threat of heavy metal in aquatic environments. Elsevier Applied Science," New York, 1990, pp. 430.
- [13] Nriagu, J.O and Pacyna J.M. 1988. "Quantitative assessment of worldwide contamination of air, water and soils by trace metals. Nature." 333: 134-139.
- [14] Yu. K.C, Tsal L.J, Chen. S.H, and Ho. S.T, "Chemical binding of heavy metals in anionic river sediments. Water Research." 2001, 35(17): 4086-4096.

# Effects of dietary supplements of probiotics, synbiotics and phytobiotics on growth performance and carcass characteristics of broilers under heat stress

Ali Asna ashari Isfahani<sup>1\*</sup>, Morteza Yousefi<sup>2</sup>, Amir Ali Solati<sup>3</sup>

1-MS.C student of Azad university of Saveh(a.asnaashari@yahoo.com) 2- Professor of animal science department(myousefi1349@gmail.com) 3- Professor of veterinary department of Azad university of Saveh(amiralisolati@yahoo.com)

**Abstract-** In order to investigate the dietary effects of growth promoters in broilers under heat stress conditions, 256 male one-day old hybrid "ROSS 308" broilers were investigated using a 2 × 4 factorial experiment in a completely randomized design. In this experiment, treatment number is 8 and replications are estimated to be 4. Dietary treatments consisted of: 1-control (without any feed additives); 2-control treatment with probiotic (primalac, 300 mg/kg); 3- control treatment with synbiotic (biomin IMBO, 1000 mg/kg); 4- control treatment with phytobiotic (sangrovit, 200 mg/kg). Heat stress treatments also including: 1-normal heat conditions; 2- applying 39°C heat were investigated during a 42-days experiment. The traits associated with growth performance (feed intake, weight gain, feed conversion rate) were measured weekly. In 42 days of age, four birds from each treatments group were selected and killed by random; the weight of carcass, bors of fabricious, spleen and length of small intestine were measured. Relative size of these organs was obtained with dividing the weight of bors, spleen, and small intestine by the body weight and multiplying it to 100. The yield of carcass, bors, and spleen that were under effect of treatment groups were compared with control group. The results demonstrated that average daily weight gain in period of 22-42 days showed significant difference between control and synbiotic treatment; so that, synbiotic treatment had more average weight gain in compare with other treatments. In total 42 days period, there was a considerable numerical difference between control and experimental treatments of synbiotic and phytobiotic. But effect of heat stress and interaction effect didn't have any effect on average daily weight gain. Generally, the results demonstrated that adding growth promoters causes improvement of growth and some of carcass characteristics.

**Keywords-** Broiler, growth, growth promoters, carcass characteristics

## 1-Introduction

Poultry Cultivation industry has been considered as an important economic activity in many countries. In large-scale of cultivation, the problems associated with the disease and worsening environmental conditions often occur when the birds were subject to stressful situation, leading to serious economic losses are Today, due to the mixture of human knowledge and natural effects, broilers with fast growth ability have been produced, but this fast growth can impose high pressure to the physiologic system of birds' body. Moreover, sensitivity to various types of stress will be increased in the birds, and

thermal stress is estimated to be one of the most important ones. Heat stress is the bird's response to excessive ambient temperature; if the humidity goes above normal, then bird will be under heat stress conditions. Heat stress in the poultry leads to increased respiration, increased blood hydrogen pressure caused by loss of carbon dioxide, acid-base imbalance in the body, loss of production ability together with the production of lighter carcasses with higher fat. On the other hand, heat stress causes the excretion of body electrolytes including sodium, potassium, magnesium, calcium, phosphor, iron, zinc, molybdenum, copper, and bicarbonate that reduces blood concentration and leads to the reduction of Hematocrit or a decrease in the concentration of red blood cells. Adapting the poultry and birds to heat is one of the ways to deal with damaging effects of heat stress. It has been proved that, if broilers are subject to high ambient temperature at early ages, their ability under future heat stress will be significantly increased. Harmful effects of heat stress considerably through some of managerial factors such as proper ventilation of room, darkness during heat stress, reduced crowding the hall, adapting the birds to the heat and also some dietary deprivations factors by modification of diets and removal of excess dietary protein. This phenomenon is called accustom. This method of adapting the birds is performed before actual heat stress with an artificial heat stress, in order to reduce their sensitivity against future stresses. Aside from heat stress that can be the cause of several diseases, controlling the diseases also should be considered. Prevention and controlling diseases during recent decades cause growing use of veterinary drugs. However, the usefulness of antimicrobial factors has been always under question as an evolution of preventing from diseases. There are many evidences about pathogen bacteria resistance against antimicrobial factors. An intestinal disease is one of important concerns of poultry cultivation industry, due to the reduced productivity, increased fatality and pollution of birds' products for human use. Food security of humans depends on the health and reduction of infective diseases in the poultries. An increase of each aforementioned challenge which can be resulted from digestive diseases is associated with antibiotic resistance. The purpose of antibiotic resistance is the resistance of several coliform infections against various antibiotics. If such thing happens, immunity system will be attenuated and resistance against all types of infections will be decreased seriously. Inhibition of using antibiotics as a growth promoter for the birds and concern about adverse effects of using them as treatment factors have enforced both producer and consumer

of antibiotics to search for alternatives. By inhibiting the use of antibiotics in Europe and expanding this inhibition to America Continent increased research interest to find appropriate alternative for antibiotic. The use of prebiotics and probiotics are two similar approaches that has the potential to reduce enteric disease in poultry and subsequently safe use of poultry products in the future. Interests in the intestine microbiology flourished in the late 1800s to the early 1900s and active researches have been performed on the efficacy of lactic acid and lactose bacteria feeding around the 20th century [7]. In 1907, a Russian scientist Mechnikov reported the increased lifetime of Bulgarian people use yoghurt as a probiotic food, he also suggested that natural bacteria are useful and using lactic acid bacteria of yoghurt has positive effect on human health. Once some of inside the body and outside the body studies showed that increased useful bacteria in small intestine prevent from pathogens activity, it was found that any disorder in natural bacteria population of small intestine can increase sensitivity to infection and resistance to infection will increase by adding probiotic and prebiotic [8]. The term "probiotic" in Greek means "for life"[5]. Probiotics are known as alive microbial dietary supplement that have positive effects on a group of animals by improving microbial balance of intestine [4]. Moreover, probiotics are good alternative for filling the large gap of antibiotic and some farmers use them prior to antibiotics. Expansion of better alternatives for antibiotics, such as adding non-digestive ingredients that increase the growth of microbes or beneficial microorganisms is important [1]. This importance directs researchers' mind to another beneficial dietary supplement called prebiotic. Prebiotics are non-digestive nutrition influencing the host by selective promotion of growth or activity of one or limited number of bacteria in colon. Prebiotics are herbal extracts or compounds derived from some plants. They are not digested in upper parts of digestion system, and moves to the lower parts of it, and provides useful physiologic effects on the proper promotion of growth or activity of few natural bacteria in colon of large intestine [5]. Symbiotics referred to a combination of prebiotics and probiotics [2]; Prebiotics and probiotics are a combination of useful bacteria and some of herbal extracts that enables each other's effects as synergism, so that have better efficiency in digestion system rather than separated form. If probiotics are used without combination of prebiotics, they will not have good efficiency in digestion system; it can be a good reason to use Symbiotics as a supplement in dietary of the birds and farm animals. Prebiotics provide a good environment for progress and expansion of probiotics. Aside from all above discussions, herbal products with medical features shouldn't be neglected; these supplementary nutrition are known as phytobiotics. From the perspective of medical effects, excessive use of this nutrition is well known in human life and appropriate alternative for drugs. Huge number of inside body and in vitro studies confirm extensive range of phytobiotics activity in animal nutrition as stimulation of food intake, germicidal features, fixing Coccidiosis, vermifugal features and stimulation of immunity system [6]. All natural and beneficial supplements are needed for the production of a useful product safe for human nutrition. Healthy animal production with economic goods, improves the health of future generations and also the future of agricultural economy.

## 2-Materials and Methods

256 male one-day old hybrid "ROSS 308" broilers were investigated using a 2 × 4 factorial experiment in a completely randomized design. 8 treatments were used in this experiment. Dietary treatments consisted of: 1-control (without any feed additives); 2- control treatment with probiotic (primalac, 300 mg/kg); 3- control treatment with synbiotic (biomin IMBO, 1000 mg/kg); 4- control treatment with

phytobiotic (sangrovit, 200 mg/kg). Control group does not receive any additives. The base diet was set based on dietary requirements ordered by cultivation guide of ROSS 308.

**Table 1. food rations used in the diet of broilers in different cultivation stages**

Food (%)	Starting diet (0-10)	Diet for growing (11-24days)	Final diet (25-42)
Corn	57.5	61.2	65
Soy	37.14	33.5	29.49
Oil	1	1.6	2
Bottled Mussels	1.3	1.04	1.03
Di-calcium phosphate	1.81	1.6	1.5
Salt	0.33	0.33	0.33
Vitamin-mineral	0.5	0.5	0.5
Methionine	0.14	0.09	0.07
Lysine	0.25	0.14	0.08
Total	100	100	100

**Table 1.2 Calculation Nutrition**

Metabolic energy (kcal / kg)	2860	2950	3020
Raw protein (%)	21	19.52	18.02
Calcium (%)	0.99	0.84	0.81
Phosphorus (%)	0.47	0.42	0.4
Sodium (%)	0.15	0.15	0.15
Lysine (%)	1.33	1.61	1.01
Methionine (%)	0.48	0.42	0.38
Methionine + cysteine (%)	0.81	0.73	0.67
Tretinoin (%)	0.86	0.81	0.76

In this experiment, the broilers were cultivated during 42 days, then four birds from each treatments group were selected and killed by random; the weight of carcass, bors of fabricious, spleen and length of small intestine were measured. Relative size of these organs was obtained with dividing the weight of bors, spleen, and small intestine by the body weight and multiplying it to 100. The yield of carcass, bors, and spleen that were under effect of treatment groups were compared with control group. Heat stress was investigated within two groups: 1- desired temperature conditions of 33 centigrade in the first week, which was decreased 1.2 degrees daily. It was reached to 21 degrees at 35<sup>th</sup> day and was fixed till the end of period; 2- like the first group, but from 35<sup>th</sup> day to 42th day they were under 39 ° C daily for 7 h. Temperature was increased from 10 am to 17. Broilers were weighed weekly in gram, feed consumption and mortality were also recorded daily. FCR was calculated in three time periods from 1 to 10 days, 11 to 24 days, and 25 to 42 days and the killing and sampling were done through two separated stages to evaluate the effect of experimental treatments on the traits of carcass.

## 3-Data analysis method

All the data were statistically estimated by using factorial 4\*2 as a completely randomized design by the help of SPSS software, after collecting and measuring the information and transferring them into Excel. Comparison of the means was performed using Dunn's multiple range test at the level of 5% probability. Statistical model of this study are as follows:

$Y_{ikt}$  = statistical model of the observations

$\mu$  = mean



$\alpha_n$  = factor related to nutrition and its additives  
 $\beta_L$  = factor related to heat stress  
 $(\alpha\beta)_{KL}$  = interaction between nutrition and heat stress  
 $\varepsilon_{nL}$  = experimental error  
 $Y_{iKL} = \mu + \alpha_K + \beta_L + (\alpha\beta)_{KL} + \varepsilon_{iKL}$

Treatments include:

- 1) Control and normal; 2) control and heat stress conditions; 3) probiotic and normal state; 4) probiotics and heat stress; 5) Symbiotic and normal state; 6) sinobiotic and heat stress; 7) phytobiotic and normal state; 8) phytobiotic and heat stress.

#### 4-Results

##### 4-1- The main effects of dietary treatments and temperature on daily weight gain in different weeks of experiment

At this part of experiment, none of treatments fed by dietary supplements have shown significant difference with control treatment. Temperature or heat stress has no significant effect on broilers' daily weight gain as well. There was also no significant differences between treatments ( $P < 0.05$ ), (see table 2).

**Table 2. The main effects of dietary treatments and temperature on daily weight gain in different weeks of experiment (gr/week)**

Daily weight gain	1 <sup>st</sup> week	2 <sup>nd</sup> week	3 <sup>rd</sup> week	4 <sup>th</sup> week	5 <sup>th</sup> week	6 <sup>th</sup> week
Effect of dietary treatments						
Control	13.5	25.9	40.2	64.8	82.5	84.6
Probiotics	14.2	25.2	40.2	61.4	83.6	85.8
Symbiotics	14.8	26.9	38.1	67.1	89.8	86.8
Phytobiotics	14.4	27.8	39.5	68.3	88.4	85.9
SEM	0.16	0.303	0.51	1.22	1.03	0.53
p-value	0.055	0.072	0.416	0.266	0.062	0.552
Effect of Temperature						
Normal	14.2	26.5	39.7	64.5	85.7	85.05
Stress	14.2	26.6	39.3	65.9	86.5	86.6
SEM	0.23	0.43	0.73	1.73	1.46	0.75
p-value	0.914	0.873	0.667	0.682	0.677	0.158

##### 4-2- The interactions of dietary treatments and temperature on daily weight gain in different weeks of experiment

The interactions between dietary treatments and heat stress on daily weight gain were not significant at 0.05 level of probability. There was no significant difference between control treatment and the treatments fed by dietary supplements. There was also no significant differences between treatments (see table 3).

**Table 3. Mutual effects of dietary treatments and temperature on daily weight gain in different weeks of experiment (gr/week)**

Daily weight gain	1st week	2ndweek	3rd week
Dietary treatments			
Control	Normal	13.5	25.3
	Stress	13.4	26.4
Probiotics	Normal	14.1	26.2
	Stress	14.2	24.6
Symbiotics	Normal	14.2	26.7

	Stress	15.4	27.04	37.8
Phytobiotics	Normal	14.9	27.6	38.9
	Stress	9.13	28.1	40.1
SEM		0.59	0.84	1.41
p-value		0.226	0.497	0.853
Daily weight gain		4th week	5th week	6th week
Dietary treatments				
Control	Normal	59.7	81.8	84.6
	Stress	9.69	2.83	6.84
Probiotics	Normal	59.7	81.9	85.03
	Stress	69.9	85.3	86.7
Symbiotics	Normal	68.6	91.1	84.4
	Stress	65.7	88.4	89.3
Phytobiotics	Normal	67.7	87.6	86.1
	Stress	69.02	89.2	85.8
SEM		3.38	2.93	1.47
p-value		0.2	0.769	0.364

##### 4-3- The main effects of dietary treatments and temperature on broilers' weight in different weeks of experiment

In the first week of the experiment, no significant difference was created between the test and control treatments. But in the second week, a significant difference was apparent between the treatments fed by supplements and control treatment. A significant difference was seen between Symbiotic treatments and the control treatment, and also phytobiotic treatment and the control treatment. But there was no significant difference between probiotic and control ( $p < 0.05$ ). Among the experiment treatments, there were also significant differences between probiotic treatment and the two Symbiotic and phytobiotic treatments. Broilers' weight was significantly increased in the treatments fed by Symbiotic and phytobiotic rather than the control; the increase in phytobiotic was little more than Symbiotic. Among the experiment treatments, increased body weight in Symbiotic and phytobiotic was more than probiotics, and was the most in phytobiotic treatment. The effects of temperature and heat stress on broilers' weight became significant and there was no significant difference between control and heat stress treatments (see table 4).

**Table 4. The main effects of dietary treatments and temperature on broilers' weight in different weeks of experiment (gr/broiler)**

Daily weight gain	1st week	2ndweek	3rd week
Effect of dietary treatments			
Control	8.137	<sup>b</sup> 319.1	600.6
Probiotics	142.4	<sup>b</sup> 320.3	602.01
Symbiotics	147	<sup>a</sup> 335.1	601.5
Phytobiotics	144.4	<sup>a</sup> 339.2	615.7
SEM	1.11	2.62	5.23
p-value	0.055	0.038	0.76
Effect of Temperature			
Normal	142.7	327.9	606.1
Stress	143.04	328.9	603.9
SEM	1.57	3.72	7.42
p-value	0.914	0.861	0.836
Daily weight gain			
	4th week	5th week	6th week
Effect of dietary treatments			
Control	1054.4	1631.8	2224.4
Probiotics	1031.8	1617.4	2218.5
Symbiotics	1071.5	1700.03	2307.8
Phytobiotics	1094.2	1713.2	2315.1

SEM	11.05	13.02	14.59
p-value	0.325	0.051	0.06
Effect of Temperature			
Normal	1060.5	1660.1	2255.5
Stress	1065.5	1671.1	2277.4
SEM	15.71	18.5	20.73
p-value	0.827	0.678	0.463

#### 4-4- The interactions of dietary treatments and temperature on broiler s'weight in different weeks of experiment

In both normal and heat stress conditions, there was no significant difference between control and experimental treatments (see table 5).

**Table 5. The interactions of dietary treatments and temperature on broiler's weight in different weeks of experiment (gr/broiler)**

Dietary treatments		Temperature	1st week	2nd week	3rd week
Control	Normal		138.1	315.4	598.7
	Stress		137.5	322.9	602.4
Probiotics	Normal		142.1	325.5	613.5
	Stress		142.7	315.2	5590.5
Symbiotics	Normal		143.1	330.02	598.3
	Stress		150.9	340.2	7/604
Phytobiotics	Normal		147.7	341.1	613.8
	Stress		140.9	337.4	8/617
SEM			3.67	7.39	14.6
p-value			0.226	0.489	0.756

**Table 5.1. The interactions of dietary treatments and temperature on broiler's weight in different weeks of experiment (gr/broiler)**

Dietary treatments		Temperature	4th week	5th week	6th week
Control	Normal		1017.2	1590.03	2182.5
	Stress		1091.7	1673.7	2266.1
Probiotics	Normal		1059.1	1633.1	2228.2
	Stress		1004.6	1601.7	2208.7
Symbiotics	Normal		1078.4	1716.3	2307.1
	Stress		1064.6	1683.6	2308.5
Phytobiotics	Normal		1087.4	1700.8	2303.8
	Stress		1100.9	1725.5	2326.4
SEM			30.61	36.45	40.62
p-value			0.281	0.403	0.66

#### 4-5- The main effects of dietary treatments and temperature on carcass characteristics

During the experiment conducted in 42<sup>th</sup> day, dietary supplements effect (probiotics, Symbiotics and phytobiotics) on carcass characteristics of broiler chickens were evaluated. The effect of the treatments on live weight, carcass weight and the ratio of small intestine weight to the total body weight and also spleen were significant, but on the other hand, there was no significant effect on carcass yield and the ratio of Bursa fabricius to the body weight. About the live weight, there was no significant difference between the treatments fed by supplements and control treatment. There was also no significant difference between the treatments fed by probiotics and control treatment, but there was a significant difference between the treatments fed by Symbiotics and phytobiotics and control treatment. Symbiotics and phytobiotics treatments showed significant more live weight than control treatment. There were also no significant differences between the treatments fed by supplements. Probiotic treatment had less live weight than Symbiotic and phytobiotics

treatments, Symbiotics treatment had also more live weight than phytobiotics treatment. Therefore, the highest live weight is for Symbiotics treatment. Dietary supplements were also effective on the carcass weight, and there was significant difference between experimental treatments and control. The treatments fed by probiotics had more carcass weight than control treatment, Symbiotics and phytobiotics treatments had also more carcass weight than control treatment. There were significant differences between experimental treatments. Dietary supplements had also significant effect on the ratio of small intestine and total body weight, there was significant difference between the treatment fed by probiotics and control treatment; the ratio of small intestine and total body weight in the treatment fed by probiotics was more than control treatment. There was no significant difference between the treatment fed by Symbiotics and control treatment. There was a significant difference between the treatment fed by phytobiotics and control treatment, and the ratio of small intestine and total body weight in the treatment fed by phytobiotics was more than control treatment. Among the treatments, probiotics and Symbiotics treatments had significant difference. The ratio of small intestine and total body weight in probiotics was more than Symbiotics treatment; the highest ratio was for probiotic treatment. There was no significant difference between Symbiotics and phytobiotics treatments, meant that both of them increase the ratio of small intestine and total body weight similarly. Dietary supplements had also significantly changed the ratio of spleen to the total body weight; and the ratio of spleen to the total body weight has significantly increased. There was a significant increase in the ratio of spleen to the total body weight in the treatment fed by probiotics. In the treatment fed by Symbiotics, the ratio of spleen to the total body weight showed significant reduction. There was no significant difference between phytobiotic and control treatments. There was also a significant difference between experimental treatments. The ratio of spleen in probiotic treatment was significantly more than Symbiotic, and phytobiotic was also higher than Symbiotic treatment. The effect of heat stress on carcass characteristics was also insignificant (see table 6).

**Table 6. The main effects of dietary treatments and temperature on carcass characteristics**

Carcass characteristics	Live weight	Carcass weight	Carcass yield
Effects of dietary treatments			
Control	<sup>b</sup> 2227	<sup>b</sup> 1509	<sup>b</sup> 8.67
Probiotics	<sup>b</sup> 2223	<sup>a</sup> 1574	<sup>a</sup> 70.8
Symbiotics	<sup>a</sup> 2269	<sup>a</sup> 1557	<sup>ab</sup> 68.7
Phytobiotics	<sup>ab</sup> 2247.3	<sup>a</sup> 1577	<sup>ab</sup> 70.2
SEM	10.33	13.62	0.75
p-value	0.046	0.026	0.072
Effect of Temperature			
Normal	2253	1559	2.69
Stress	2230	1549	6.69
SEM	7.304	9.63	0.53
p-value	0.053	0.463	0.71

Carcass characteristics	Small intestine	Spleen	Bors
Effects of dietary treatments			
Control	<sup>b</sup> 2.49	<sup>c</sup> 0.082	<sup>b</sup> 0.205
Probiotics	<sup>a</sup> 2.62	<sup>a</sup> 0.105	<sup>a</sup> 0.218
Symbiotics	<sup>b</sup> 2.4	<sup>d</sup> 0.065	<sup>d</sup> 0.178
Phytobiotics	<sup>a</sup> 2.65	<sup>c</sup> 0.095	<sup>c</sup> 0.193
SEM	0.032	0.003	0.004
p-value	0.001	0.000	0.217
Effect of Temperature			
Normal	2.53	0.089	0.195
Stress	2.52	0.085	0.201
SEM	0.022	0.002	0.003
p-value	0.114	0.217	0.134

#### 4-6- The interactions of dietary treatments and temperature on carcass characteristics

The interaction of dietary supplements and temperature on carcass characteristics was not significant. In both normal and heat stress conditions, dietary supplements had no significant effect on carcass characteristics.

**Table 7. The interactions of dietary treatments and temperature on carcass characteristics**

Carcass characteristics		Live weight	Carcass weight	Carcass yield
Dietary treatments	Temperature			
Control	Normal	2220	1510	68
	Stress	2233	1508	67.6
Probiotics	Normal	2251	1570	69.8
	Stress	2194	1578	71.9
Symbiotics	Normal	2273	1568	69
	Stress	2264	1547	68.4
Phytobiotics	Normal	2268	1590	70.1
	Stress	2227	1564	70.2
SEM		14.61	19.26	1.06
p-value		0.153	0.803	0.558
Carcass characteristics		Small intestine	Spleen	Bors
Dietary treatments	Temperature			
Control	Normal	2.46	0.085	0.205
	Stress	2.53	0.8	0.205
Probiotics	Normal	2.62	0.11	0.21
	Stress	2.76	0.1	0.225
Symbiotics	Normal	2.42	0.065	0.18
	Stress	2.39	0.065	0.175
Phytobiotics	Normal	2.63	0.095	0.185
	Stress	2.68	0.095	0.2
SEM		0.045	0.045	0.004
p-value		0.359	0.561	0.21

#### 5-Conclusion and Recommendations

One of the most important challenges in livestock and poultry industry is the indiscriminate use of chemicals and antibiotics. Effective methods to combat these harmful mistakes is using natural and effective dietary supplements which is not harmful for the animals but also very beneficial. Very popular supplements in this

field include probiotics, Symbiotics, and phytobiotics which are most effective on the microflora balance of digestion system and increased efficiency of immunity system. These profitable supplements that are germicide and able to increase antibody titre, can decrease the use of growth promoter antibiotics in the body. Further reduction of the chemicals in the poultry breeding help the breeders of this important industry to quickly start producing organic products. Organic products have no chemicals and antibiotics, and their production requires natural and inherent cultivation of animals without any manipulation in the growth process. It will be possible only through the gradual elimination of harmful chemicals in animal breeding and make them compatible with beneficial supplements.

#### References

- [1.] Awad, W.A Ghareeb, K. Abdel- raheem , S. Bohm , J. 2009. *Effects of dietary inclusion of probiotic and symbiotic on growth performance , organ weight , and intestinal histomorphology of broiler chickens . poultry science* 88: 49-55.
- [2.] Collins, M.D and G.R Gibson. 1999. *Probiotics, prebiotics and symbiotics: approaches for modulating the microbial ecology of the gut. Am. J. Clin. Nutr.* 69 (Suppl. 1): 1042S-1057S.
- [3.] Fuller, R. 1989. *Probiotics in man and animals. J. Appl. Bacteriol* 66:365-378.
- [4.] Gibson, G.R and M.B Roberfroid. 1995. *Dietary modulation of the human colonic microbiota: introducing the concept of prebiotics. J. Nutr.* 125:1401-1412.
- [5.] Gibson, G.R and R.Fuller. 2000. *Aspects of in vitro and in vivo research approaches directed toward identifying probiotics and prebiotics for human use. J. Nutr.* 130:391S-395S.
- [6.] Panda, A.K. Rama Rao, S.V. and Raju, M.V.L.N. 2006. *Dietary supplementation of probiotics during the late laying period in production performance of white Leghorn layer breeders and their progeny. Indian Journal of Poultry Science* (Accepted).
- [7.] Rettger , L. F. and H. A. Cheplin. 1921. *A Treatise on the Transformation of the Intestinal Flora*, with Special Reference to the Implantation of Bacillus acidophilus. Yale University Press New Haven, CT.
- [8.] Stavric, S. and E. T. Kornegay. 1995. *Microbial probiotics for pigs and poultry. Pages 205-231 in Biotechnology in Animal Feeds and Animal Feeding.* R. J. Wallace , and A. Chesson .

# An investigation on the effectiveness of education by mass media (film) on promotion of environmental knowledge, a sustainable development approach

S.Mohammad shobeiri<sup>1</sup> · Mina aslani<sup>2</sup>

**Abstract**— This study was conducted to consider the impacts of mass media on environmental knowledge of Shahid Rajaei Teacher Training university's students. To fulfill the goals of this study, a questionnaire was prepared, the validity of it was considered by practitioners and its reliability was confirmed and calculated to be 0.77. The pretest-posttest design was implemented on the experimental and control groups. A random sample of 60 bachelor students out of 1450 students of Shahid Rajaei Teacher Training University for whom there was no environmental course in their curriculum was taken. They were divided into experimental and control groups. For the later one, an environmental training by mass media was presented whereas the first group did not receive any kinds of environmental education. The final data were analyzed by t-test. The results of this study showed a significant difference between the environmental knowledge of individuals who have received environmental education.

**Keywords**—environmental knowledge, mass media, sustainable development.

## I. INTRODUCTION

Nowadays, the environment is exposed to national and international threats. The list of these threats is multiple from climate change to biodiversity loss and different kinds of anthropogenic and natural pollutions which has threatened the life-being on the earth. Combat against these threats needs a national consensus and environmental educations can cause incentive in people to rescue the environment [1]. Now, national and governmental organizations try to use this potential to prevent environmental disasters in the future. Most of the environmentalists names

the twenties century, the tragic century due to these environmental disasters. Since environmental education can enlighten the people's attitude toward environment so, it has been one of the top priorities in most of the environmental conferences [2]. Environmental education like other disciplines is based on three priorities, knowledge, attitude, and expertise [3].

Environmental education consists of identification of values, explanation of concepts to create related expertise and fields of studies to acknowledge the relationship among human environment and cultures[6]. Education is the most important available option to refer to sustainable development in the current century. Sustainable development is a kind of development through which we would have a holistic approach toward environment, while human's well-being is also taken into account.

In the current century, media has an undisputed role in the education of societies. Due to different cultures, every person would prefer different kinds of media. Through various, suitable and tailor-made mass media we can render a successful current toward sustainable development[11]. mass media (including TV, Cinema, the press, etc) are powerful instruments to impart idea, messages and concepts to the society[12]. Since media has an undeniable role in culture creation, so, they can be utilized for environmental education as well.

Badkobi et al. in a study concluded that as the environmental awareness of teachers in Iran is low so, the press has not been so successful in environmental education however, since these people spend a great deal of their time to watch TV in their leisure time so, this potential can be used for the environmental education of these teachers. The results of this study also proved that 73.7 percents of respondents has regarded TV and radio as the best mass media for environmental education [15].

Safari (2009) has regarded mass media as the best option for environmental education of housekeepers in Tehran city[17]. Behroozi rad et al.(2010) in a study on the environmental awareness of local people in Yasooj city using questionnaire concluded that attitude of people toward wild

<sup>1</sup> Associate professor, Department of Environmental Education, Payamenoor University. (e-mail: smshbeiri@yahoo.com)

<sup>2</sup> Master of Science in Environmental Education, Department of Environmental Management Planning, Science and Research Branch, Islamic Azad University, Tehran, Iran (corresponding author to provide phone: 0098-021-22970060; e-mail: aslanimina@yahoo.com).

life conservation is low and multimedia has the highest role in creation of environmental culture and ethnic[18]. Mirdamadi et al.(2009) considered the ways the people acquire their required information related to environment and concluded that 39.8 percent of respondent have acquired their information toward environmental conservation by TV while 8.2 percents by magazines. For the high school students in Tehran, the amount of information toward environment by TV was medium and their usage of environmental books and papers have been lower medium and low, respectively [19].

Ostovar(2009) showed that mass media such TV, Radio and Internet besides book have a prominent role in the awareness of students so, the information of students toward environment is acquired by different sources such as school, mass media and non-course book[20].

Salehi and Hematti(2012) showed that multimedia should be used for education since some people use multimedia such as TV and Radio for acquisition of information while for the other target groups it is acquired by the press thus depending on different strata and ages the type of education is various otherwise it would not fulfill the required goal[21].

With respect to most of the researchers non-formal method of education should be referred for environmental education (Barbas et al.2009;Lui et al.2006;Norman,2000). For instance, movies as a non-formal environmental instrument can be utilized for environmental education. In this regard, movies can change the attitude and behavior of people toward environment. In addition Lui et al. (2006) believe that movies can increase the environmental concern among people in the society and provoke them to take action against environmental disasters.

Since the main goal of this study was to consider the impact of multimedia on environmental education of Shahid Rajae Teacher Training University's students to fulfill the goals of sustainable development, so the main question addressed was:

Whether or not environmental education by mass media can augment the environmental knowledge of students toward environment?

### Material and method

This study consider the impact of an independent parameter (visual mass media such as movie,clips,etc) on a dependant parameter(environmental knowledge). The goal of this study was implemented through pre-test-post test design on experimental and control groups. Sixty out of 1450 bachelor students at Shahid Rajae Teacher Training University for whom there was no environmental course in their curriculum were randomly selected. These samples were divided into two groups namely experimental and control groups. Since there was no standard questionnaire in this field, so multiple choice test items were used regarding the goal of this study which was the impacts of multimedia on environmental awareness. The subjects that were considered in these questionnaires were environmental disasters (such as air,water and soil pollution, waste management, wild life conservation, climate change,

ozone depletion etc). To examine the validity of these questions, they were perused and approved by 10 environmental researchers and practitioners. To examine the reliability of these questionnaires they were distributed among 30 students and the results was analyzed by SPSS software indicating a Cronbach's alpha of 0.77 which approved the reliability of these questionnaires. The data collection was implemented by this questionnaire containing 30 questions and through pretest-posttest design. Before environmental training, the contents of environmental movie and clips were tailor-made to the contents of questionnaires.

During environmental training by visual mass media, the group was trained during 10 sessions in which each individual was trained by a 40 minutes movie in each session. For experimental group the questions of students were addressed while this procedure was not followed in test group. In both groups a pretest-posttest design was followed using the same kind of questionnaires. The data then were analyzed by statistical methods. Since one of the goals of this study was comparison between the mean of these two groups, so, t-test was used for this purpose. Levene's Test for equality of variances was used and the normality of data was considered by Kolmogorov–Smirnov test.

### Results and discussion

To answer the question posed in this study the results of t-test is presented to consider the impacts of visual mass media on the environmental training of students besides the descriptive statistics. The table 1 and table2 render the homogeneity of the mean of environmental scores of students. The mean and standard deviation of these scores have been presented in table1. The mean of pretest results was the same meaning that they did not differ in this field.

#### I. Mean comparison of environmental knowledge in pre-test of both experimental and control groups

Std. Deviation	Mean	N	Group	variable
5/240	44/17	30	pre-test of control	Level of environmental knowledge
4/592	44/13	30	pre-test of experimental	

On the contrary, the mean of environmental knowledge between experimental and control groups were significantly different according to table2. Levene's Test for equality of variances was equal to 0.731 indicating the variance of these two groups were equal and the t-test was significant since its t-statistic was equal to 0.396.

II. The results of Levene's and t-test for comparison of environmental knowledge in pre-test of both experimental and control groups

t-test for Equality of Means				Levene's Test for Equality of Variances		variable
Mean Difference	Sig. (2-tailed)	df	t	Sig.	F	Level of environmental knowledge
0/3	0/979	58	0/26	0/396	0/731	Equal variances assumed

Considering the results of table2, we can conclude that there was no significant difference between the environmental knowledge of these two groups (significant level of 0.979 and t-statistic of 0.26). Thus, before these two groups are exposed to visual mass media they were not different from the view point of environmental knowledge. Table3 contains the mean and standard deviation of posttest design on respective groups. The mean of these two groups are obviously different. However, the significant difference between these two groups was considered by t-test for posttest design in experimental and control groups. Levene's Test for equality of variances was equal to 3.696 and it had a significant value of 0.050 suggesting that the variance of these two groups is equal. On the other hand, considering t-test value of -6.562, significant level of 0.00 and df=58, we can conclude that there was significant difference between the mean of these two groups with respect to environmental knowledge. The mean of control group was 44.23 while that of experimental groups was equal to 51.77 indicating a 7.53 difference between these two groups. Therefore, we can conclude that visual mass media has increased the environmental knowledge of students. This was in accordance with the results of other researchers (Bahk, 2011; Barbas, 2009; Harness & Drossman, 2011; Lowe et al, 2006; Nolan, 2011; Norman, 2000; Badkuby et al, 2001; Mirdamadi, 2009; Ostovar, 2010;).

III. Mean comparison of environmental knowledge in post-test of both experimental and control groups

Std Deviation	Mean	N	Group	variable
5/063	44/23	30	post-test of control	Level of environmental knowledge
3/730	51/77	30	post-test of experimental	

IV. The results of Levene's and t-test for comparison of environmental knowledge in post-test of both experimental and control groups

t-test for Equality of Means				Levene's Test for Equality of Variances		variable
Mean Difference	Sig. (2-tailed)	df	t	Sig.	F	Level of environmental knowledge
-7/53	0/000	58	-6/562	0/059	3/696	Equal variances assumed

**Conclusion**

The results of this study showed a significant relationship between environmental training by visual mass media and environmental knowledge. Therefore, we recommend using of these mass media (such as movie and clips) for environmental training of students. Since the multimedia has prominent impact on culture creation so, they can be utilized to render knowledge, information and environmental training. In addition, due to the low number of these beneficial movies so, it is a good practice to consider all of the social groups during preparation of these movies for educational purposes. The environmental training will be more attractive if we use the potential of these mass media for environmental education as they are widespread.

**REFERENCES**

- [1] Environmental education programs in elementary schools in Isfahan, 2009, Available : [www.isfahan-doe.ir](http://www.isfahan-doe.ir)
- [2] Heydari, O. "Greening is a Behavior nor Method", Hamshahri Newspaper, 1999.
- [3] B. Rhadoost, " Phenomenology: environmental literacy". Journal aesthetic, 2008.
- [4] J. Frick, F. G. Kaiser, M. Wilson, "Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample". Personality and Individual Differences. 37, 1-2, 2004.
- [5] SH. Rahemi, M. Taheri, "education An essential component of promoting the Culture environment, Iran's Journal of Engineering Education" No. 24: 1-25, 2004
- [6] J. Palmer, "Environmental Education in the Twenty-first Century", Translated by Khorshidoost, A.M. First Printing, Tehran: Samt Publication, 2003.
- [7] GH. Ebrahimi, A. Abedin Moghanaki, " Methods of environmental skills training " Case Study: Teaching children (efficient schools). No. 4, 2007.
- [8] M. Eyvazi " Human development", 2006, Available : <http://www.farsnews.com>.
- [9] M. Bonnett, "Education for Sustainable Development: Sustainability As A Frame Of Mind". Journal of Philosophy of Education, Vol. 37, No. 4: 675-690, 2003.
- [10] M. Alavi moghadam et al, "The role of Education in the proper management of solid waste in Iran, Journal of human and Environment, 2004.
- [11] M. Amirteymoori, " Educational media, 3rd ed, Sasan press, 2003.
- [12] H. Sotoudeh, " Social Pathology", Avayeh noor press, 2005
- [13] B. Qoen, "Introduction to Sociology". Translated by Salasi. M, Tehran: tootyapress, 1998.

- [14] F. Mostafavi, "The impact of the mass media in changing attitudes and culture Traffic" *Journal of Rahvar*, No. 5, 2009.
- [15] F. Dabiri, A. Vahednavan, "Media and development of environmental law". *Media Studies*, 2011
- [16] A. Badkuby, S.H. Poorebrahim, M. Hadipoor, "to evaluate Tehran teachers working in the areas of education and awareness on environmental issues and methods", *Journal of Environmental Engineering*, No. 27, 2001.
- [17] A. Safari, "environmental Knowledge of Housewives Tehranin use and management of natural resources in relation to sustainable development", 2009.
- [18] B. Bhroozirad et al, "The impact of various media in environmental culture in yasuj, Fifth National Conference of environmental crises and solutions to improve", 2010
- [19] M. Mirdamadi, A. Bagheri, S. Esmaeili, "investigation of high school students's Knowledge in Tehran on environmental protection". *environmental Science and Technology*, N.1, 2009.
- [20] S. Ostovar, "investigation of knowledge and attitudes of teachers and students of Kish Island for environmental training needs Shiraz University MA Thesis", 2010.
- [21] S. Salehi, Z. Hematti Gouyom, "The role of environmental education in the electronic waste management", *journal of environmental education & sustainable development*, N.1, 2012.
- [22] C.M. Bahk, "Environmental education through narrative films: Impact of Medicine Man on attitudes toward forest preservation". *Journal of Environmental Education* 42, no. 1: 1-13, 2011.
- [23] N. Kapoor, "Role of mass media in promotion of environmental awareness along with skill development among the rural people of Shringverpur, Allahabad district, India", *International Conference on Chemical Biological and Environment Sciences (ICCEBS'2011)* Bangkok Dec., 2011.
- [24] T.A. Barbas, S. Paraskevopoulos, A.G. Stamou, "The effect of nature on documentaries students' environmental sensitivity: A case study". *Learning Media and Technology* 34, no. 1: 61-9, 2009.
- [25] H. Harness, H. Drossman, "The environmental education through film making project". *Environmental Education Research*, 17 (6), 829-849, 2011.
- [26] J.M. Nolan, "An Inconvenient Truth increases knowledge, concern, and willingness to reduce greenhouse gases". *Environment and Behavior* 42 (5): 643-58, 2010.
- [27] M.E. Norman, "Public education through community-based film programs": A report on the environmental film festival in the nation's capital. *The Journal of Environmental Education*, 31(2), 28-30, 2000.
- [28] T. Lowe, K. Brown, S. Dessai, M.D.F. Doria, K. Haynes, K. Vincent, "Does tomorrow ever come? Disaster narrative and public perceptions of climate change". *Public Understanding of Science* 16, 435-57, 2006.