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A Survey on Removal of Cadmium from Aqueous Solutions using Activated Carbon of Almond-Shell

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Abstract

Cadmium is one of the heavy metals which is entered to water resources through different ways such as industrial, home and agricultural wastewaters or as a result of unhygienic withdrawal of urban and industrial wastes. Surveys in some regions around pollutant resources show that surface waters or underground waters is contaminated to cadmium in “0.1 to 1” mg/lit [1]. Activated carbon with nano pores is a green technology for separation of poisonous material in environment. The aim of this research is to determine the level of cadmium absorption by activated carbon of almond-shell in concentration of “20 ”, “50” and “100” per part million (ppm) and different insolubility times from “15 to 120” min. Experiments for determining isotherms were assigned discontinuous in different concentrations and different amounts of biological activated carbon (from “0.1 gr to 0.3” gr) and the cadmium with desired PH. Measurement of cadmium performed by atomic absorption device and based on the standards. Observing the research results and the PH regulated on “6” , increase in primary concentration of cadmium resulted in increasing of absorption level and also by elapsing the time, absorption level was raised and the maximum absorption on “61%” was happened in time range of “120” min. The results indicate that bio absorber containing sodium alginate containing activated carbon prepared from almond shell is new adsorbent for the removal of cadmium ions from aqueous environments.

Keywords: Almond shell, Activated carbon, Biological, Cadmium.

Introduction:

Existing poisonous heavy metals in surface and underground waters may put the living beings in to danger. Cadmium is one of heavy metals which is entered to water recourses through different ways such as industrial, home an agricultural wastewaters and unhygienic withdrawal of urban and industrial wastes. maximum allowable concentration of Cadmium in the refined industrial wastewaters being evacuate to receptive waters is “0.25” mg/lit and maximum allowable concentration in potable water is “0.005” mg/lit. Surveys show that surface waters or underground waters in some of regions around pollutant sources are polluted to cadmium from “0.1 to 1” mg/lit [1]-[8].

Cadmium is a toxic element which is stored in kidneys and reacts with sulfur proteins and leads to some disorders in nervous system, blood stream, pancreas, anemia and deformation in bones conditions [2]. Cadmium is used for making nickel-cadmium batteries, inorganic chromatic pigments, TV lamp, industrial alloys, electric cable's shield, Teflon dishes, plastic resistant materials, fungicides, copier machines' ink, chemical catalyzer, heat treating and etc. [3].

Several methods exist for removal of the cadmium of aqueous environments and wastewaters including reverse osmosis, sedimentation by hydroxide or sulfide, ion-exchange, biological methods and surface absorption on the absorbent materials such as activated carbons and bio-absorption [4]-[7].

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Observing the increasing importance of water resources pollution to heavy metals and the necessity of removal of these materials from water resources and as a result of high performance of biological activated carbon system in eliminating heavy metals, this research was done. The aim of the research is to determine the efficiency of activated carbon produced by almond-shell in eliminating the cadmium in insolubility times of "15, " "30, " "45," "60," "90" and "120" min and concentration of "20", "50" and "100" ppm.

Materials and methods

1- Materials

Cadmium sulphate (3Cd SO4.8H2O) and potassium chromate (K2Cr2O7) made by Merk Company and calcium compound used was calcium chloride (CaCl2). Activated carbon with nano-pores in distribution of micro, meso, macro from "1 to 50" nanometer and sodium alginate was produced in the laboratory.

2- Activated carbon

In recent years using low-cost and varied absorbents instead of commercial activated carbon has been favored by researchers. As a result of flourishing the agriculture in several regions of the country and varieties of agricultural and garden products, removal of productive wastes from polluted waters was observed in this research. Hence the carbon produced from the shell is used to eliminating cadmium from water and also absorption level and removal level of cadmium was investigated.

To produce active carbon from almond-shell, first, almond-shell was chopped in size of "1 to 1.5" cm and kept for "24" hours in activator element - edible phosphoric acid made by Union Co. with purity of "85%" . After "24" hours it was emitted from the activator and after entering it for one hour into an oven with temperature of "800" centigrade degree it was changed to carbon. After oven operation, active carbon was rinsed by deionized water to reach to PH "6". This method is used in other researches nearly similar for making activated carbon from materials [6]-[5]. Produced active carbon was chopped and then milled and afterward it was passed through an 80-mesh riddle and finally the activated carbon with nano-pores was made.

Properties of activated carbon of almond shell are as Table 1.

Table 1 – Properties of activated carbon of almond shell

Parameter	Special surface (m^2/g)	Single point special surface (m^2/g)	Density (cm^3/ g)	Moisture (%)	Particles size (mm)	Volume of closed porosities (cm^3/g)
activated carbon	13.5807	15.8605	1.8065	negligible	0.5-0.65	0.1751

3- Preparing sodium alginate spherical

"1%" solution (W/V) of alginate sodium was prepared by solving "1 gram of it into "100" ml of deionized water. Alginate sodium dissolves slowly in water by use of a mixer for "20" minutes and a jelly like solution will be made. Similarly we can dissolve alginate sodium in water through putting the solution on a heater with a moderate temperature nearly "50" centigrade degree. A "0.5" molar solution of calcium chloride was made with dissolving "13.873" g of calcium chloride in "250" cc of water [6].

The solution of calcium chloride was made by use of homogeny method in Joje balloon and then the jelly containing sodium alginate was inserted drop by drop using an insulin syringe.

In this manner, diameter of the resulted sphericals is about "2 to 3" mm. Because absorption level will be increased by reducing the bullets' diameter, syringe was used in this research that its needle was replaced by plastic sampler. After sieving the said spherical repeatedly, they were rinsed with calcium chloride "0.5 molar solution and deionized water and were kept and dried in room temperature. Then it was again dried by oven in order to fixing the weight. After drying, diameter of bullets was measured about "0.7" mm. This kind of absorbent bullet was named GM-92.

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4- Stabilizing activated carbon in alginate sphericals

First, 0.1 g of nano carbon powder was mixed in 1" g of alginate sodium powder in aridly. Then "100" ml of deionized water was added to it and by use of a handy mixer for "20" min in a room temperature of "25" centigrade degree, the alginate sodium jell was produced in which activated carbon was stabilized. The sodium alginate with nano carbon powder were dissolved slowly in water for "20"min by use of handy mixer and in this operation, a black jelly solution was resulted. Also stabilization of activated carbon with "0.2" and "0.3" g of nano carbon powder was performed and absorbent bullet made by "0.1" g of carbon nano powder was named as GM-VK-92. Absorbent spherical produced by "0.2" g of carbon nano powder was named as GM-HR-92 and the one which was made with "0.3 " g nano carbon powder was named as GM-MN-92.

5- Preparing the water polluted to cadmium

The solution of "1000" ppm cadmium was prepared using sulphate cadmium (3Cd SO4.8H2O) made by Merk company of Germany. Concentrations of "20" , " 50" and "100" ppm of cadmium solution were produced in "100" cc Erlenmeyer flask.

In order to investigating the effect of pollutants or metals, the cadmium's absorption level was surveyed by use of four types of absorption sphericals named "GM-92", "GM-VK-92", " GM-HR-92" and "GM-MN-92" of "20", "50" and "100" ppm .

6- Preparing samples and measurement

Kinetic response was surveyed on "15", "30", "45", "60", "90" min and "120" min. In such way that in the experiments for determining the isotherms, a specified weight of activated carbon (100 ml) in the produced solution containing cadmium was added to Erlenmeyer flasks in specific volume. For each specified concentration of cadmium ("20," "50" and "100" ppm), different concentrations of activated carbon ("0.1, " "0.2" and 0.3" gr) were added separately. Then the Erlenmeyer flasks were shaken on the shaker in "25" centigrade degree and "30" rpm speed. Erlenmeyer flasks were shaken for different times from "15" min to "2" hours with speed of "30" rpm and amount of the remaining cadmium was measured each time.

Absorption method used in these experiments was discontinuous system. Concentration of cadmium in the all solutions was measured by use of an atomic absorption spectrometer device – AA "240" model VARIAN.

Studying several resources about PH and because the most absorption was gained in range of PH "6", optimal PH was determined as PH=6 for this research.

To calculate the absorption percentage, formula no.1 was used.

Formula no.(1): $\mathbf{Y= (C_i – C_e)/C_i * 100}$

In which, Y, absorption percentage, Ci is the primary concentration of the solution and Ce is the final concentration of the solution.

To calculate the absorptive capacity, formula no. 2 was used.

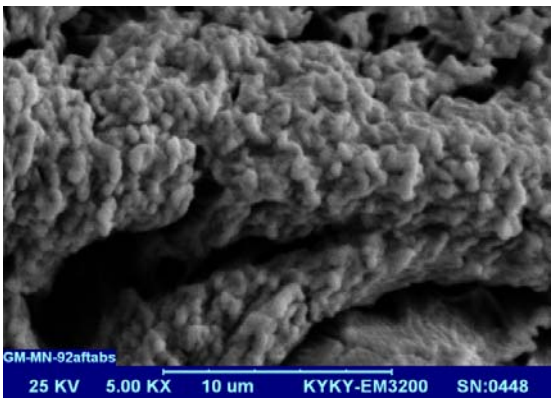
Formula no. 2: **Y= (Ci – Ce)* V/M**

In which Ci is the primary concentration of the solution and Ce is the final concentration of the solution, M, dry absorbent mass and V, mass of the solution.

Discussion

1- Results of surveying the relation between cadmium's absorption level and increase of activated carbon

Results of absorptive capacity (Q) of simple alginate sphericals and sphericals prepared by activated carbon were showed in graph no. "1" in which by increase of activated carbon, absorptive capacity of cadmium has increased to "6.1" mg/gr and the most absorption was occurred by "GM-MN-92" (absorbent contains "0.3" gr of activated carbon) which its picture captured by SEM device (electronic microscope) and has been showed in pic no. 1.



Pic no. 1: absorbent sphericals GM-MN-92 after absorption magnified by 5000 times by SEM after drying the samples.

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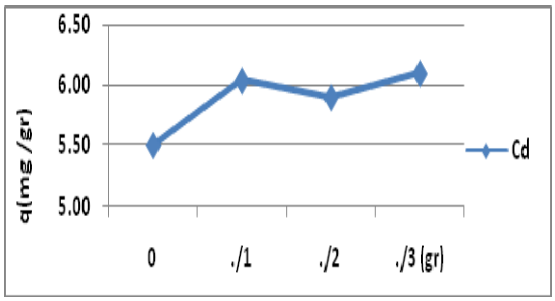
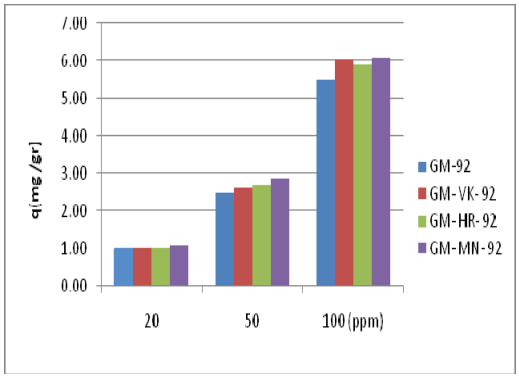


Graph no. 1: relation between cadmium absorption level and increase in activated carbon

2- Results of surveying relation between cadmium absorption and increase of volume

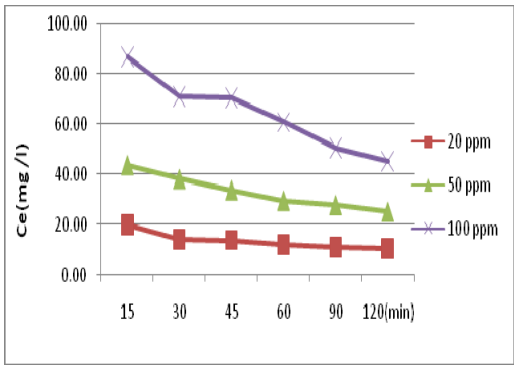
Results of atomic absorption spectrometer in pic "2," show that increase in concentration of cadmium solutions, would raise the absorption level and also by surveying the amount of active carbon in different concentrations it shows that increasing of the active carbon in absorptive bullets, would increase the absorption level (absorption percent and absorption capacity) and the most elimination level of cadmium occurs in "100" ppm.



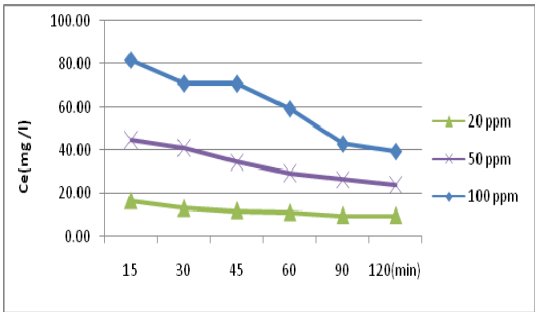
Graph 2: relation between absorption level of cadmium and increase of concentration

3- Results of surveying the relation between increase of time and absorption level of cadmium in the field of the absorbent and in different concentration

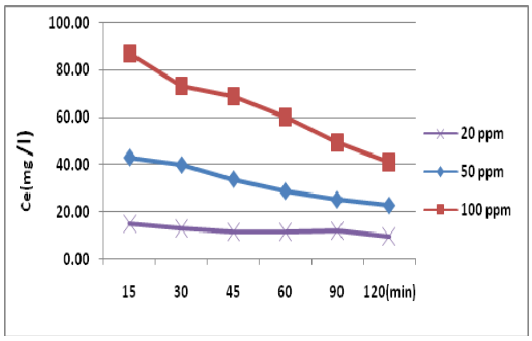
Results of the atomic absorption spectrometer in graphs "3", "4", "5" and "6" show that by increasing the time factor, absorption level of cadmium in different concentrations in absorbent sphericals containing activated carbon is also increased and also the most level of cadmium absorption in "61%" was in "120" min and in "100" ppm and absorbent sphericals in type of "GM-MN-92" which contains "0.3" gr of almond-shell activated carbon has appeared.



Graph no. 3: Kinetic of cadmium absorption versus time in the field of absorbent GM-92



Graph no. 4: Kinetic of cadmium absorption versus time in the field of absorbent GM-VK-92



Graph no. 5: Kinetic of cadmium absorption versus time in the field of absorbent GM-HR-92

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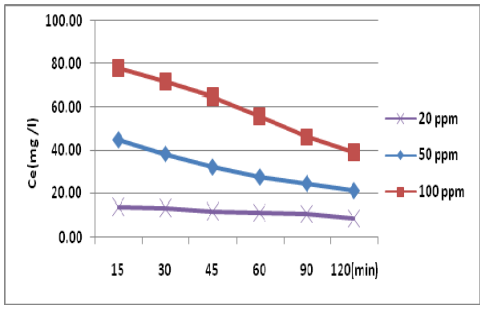

Graph no. 6: Kinetic of cadmium absorption versus time in the field of absorbent GM-MN-92

Conclusion and recommendation

Results of this research and the past studies about absorption power of alginate absorbent sphericals and active carbon in absorbing metal cations such as cadmium show that the absorptive capacity of the said absorbents is *high* for metal positive cations. In this research, an increase in absorption capacity of alginate was studied and the results showed that by increasing the activated carbon, absorptive capacity of absorbent would increase significantly and it is necessary to say that in this method, the amount of active carbon is severely low and this method is economical compared to direct use of activated carbon. Because the most absorption is occurs in 120 min and on 100 ppm, and as a result of the possibility of an increase in absorption power by elapsing the times and at higher concentrations, it is proposed to study the activated carbon in higher concentrations and with more contact times and also for absorption of other metal cations.

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Applying the Knowledge of Operational Research in Agricultural Mechanization

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***Abstract*—**Applying any technologies that leads to increase productivity in the agricultural production is interpreted as mechanization. In another definition, the mechanization is the use of technology in agriculture in order to achieve stable development. If the latter definition is considered as the basis, it can be concluded that by using the scientific achievements which is considered as a type of technology and is accelerated the development of mechanical agriculture; steps have been taken to expand mechanization. One of these scientific achievements is the knowledge of Operational research. This knowledge which is one of the branches of applied mathematics is used to facilitate decision making based on scientific criteria and constraints. In the agricultural sector in which there are various restrictions such as weather conditions, economic and social issues; taking advantage of this knowledge can help to solve problems and make the right decision. This paper introduces knowledge of Operational research and its application context in agricultural mechanization.

***Keywords*—** Agriculture, Decision Making, Mechanization, Operational research

1. INTRODUCTION

The word technology does not have Persian route and is one of those words that has many applications in the Persian language. Nowadays this word, in Iran's industrial culture, is synonymous with production machines and expresses its technical characteristics. On closer examination also technology is introduced as a method of production. Technology is considered something beyond knowledge of production and its processes. Technology is a combination of knowledge, skills and technical abilities that enables its holder to change the natural world. Technology is an attitude comes from ability and experience; tools, machinery and hardware products, are the means of this attitude. Recently, due to the globalization of communication and information, current international economic and political conditions, accelerating global evolutions, technology is needed to overcome the problems more than ever. Therefore, each organization which can take more advantages of high-tech, will be more successful in the business. Agriculture, particularly the mechanization sect, is not an exception and always for its sublimity and improvement needs to apply the modern technological achievements. This paper introduces knowledge of Operational research and also discusses the feasibility of its application in the agricultural mechanization.

2. Definition of Mechanization

Agricultural mechanization is a collection of science and technology which includes the study and application of different types of machines and tools of driving force, in various stages of production and also in processing of agricultural products. In other words, applying technology to increase productivity in agriculture in compliance with all the aspects is mechanization. But there is another understanding which states applying any technologies that leads to increase productivity in the agricultural production is interpreted as mechanization. Mechanization is the use of technology in agriculture in order to achieve stable development. If the latter definition is considered as the basis, it can be concluded that by using the scientific achievements which is considered a type of technology and is also used in the development of mechanical agriculture, steps have been taken to expand mechanization. One of these scientific achievements is the knowledge of research in operation. This knowledge which is one of the branches of applied mathematics, is used to facilitate decision making based on scientific criteria and constraints. In the agricultural sector in which there are various restrictions such as weather conditions, economic and social issues; taking advantage of this knowledge can help to solve problems and make the right decision.

3. Overview of Operational research

Operational research is the application of a scientific approach to solving management problems, and seeks to help managers to make better decisions. Operational research focuses on a set of mathematical techniques that are either have been developed in the field of "Management science" or have been derived from the other natural sciences, mathematics, statistics and engineering. Although Operational research is a new type of science, it is very well known and established in industry and business. Applications of this science are very broad and its commonly application in

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industrial and commercial establishments clearly demonstrate authenticity of it. Many studies have been conducted on the application of Operational research techniques. It has been found that the results of applying this procedure is very satisfactory. So, today this science in many disciplines is taught as a compulsory subject and also in many universities is taught in the form of an independent discipline. Operational research is usually expressed in such titles as; Management science of quantitative methods, Quantitative Analysis and decision making science. In many texts (including this paper) rather than "Operational research" the short term OR is used.

3.1. The Emergence of Operational research

Operational research is developed and expanded during World War II by English scientists. At that time, the British military administration employed a group of scientists- those who were expert in tactical and strategic issues related to air and ground defense- to research in this field. The main reason for these studies was the shortage of military budget and resources. Thus, the study of how to make good and maximize use of military system resources was necessary. As it is understood from the title Operational research, it was because of the nature of team's research on military operations. The name "Operational research" or "research in the operation" or simply "OR" is widely used recently for a new way of scientific and systematic study of operations. After the war, the military groups' success drew the attention of industrial managers. Managers seek alternatives for their problems which were caused by the arrival of job specialization in business that got worse day after the day. Despite the fact that originally specialized jobs are created to serve the overall objectives of an organization, individual goals of these jobs may not always be consistent with the objectives of the organization. This situation has led to a complex decision making problems that eventually forced the organizations to seek the most effective ways to use OR. In 1947 George Dantzig devised the simplex method to solve problems of Linear Programming which was the first and most important achievements of this research. Some of the conventional means of Operational research, such as dynamic programming, queuing theory and theory of inventories up to 1950 were relatively advanced. Effective progress in the field of Operational research largely was due to the simultaneous development of the computers, which has computational speed and supernatural ability to store and recall information. In fact, if computers were not invented, Operational research, with large-scale computational problems, has not achieved the present promising position in various fields of business.

3.2. Definition of Operational research

Operational research based on different users has different definitions. Depending on the application of this science in different organizations by different users, the most important definitions of OR are as follows:

1. Operational research is a set of scientific methods and techniques to identify problems within the system and is used to seek the ideal alternatives for the issues.
2. Operational research is the application of scientific methods to study complex activities and operations of large organizations.

Perhaps the most important definition for the OR is expressed as: the application of scientific method to analyze and solve problems of management decision making. What is more than anything represents the OR is its features that will be discussed in later sections.

3.3. Decision Making: The Focus of OR

A decision is the result of the selection process of a better option between two or more different options that helps to achieve the objectives. This process is called decision making. According to Herbert Simon, decision making is synonymous with the entire management process. To illustrate the significance of decision making, look at other management tasks such as planning. In the definition of Planning, it has been said that planning consists of a collection of decisions, such as what should be done? How? Where? By whom?

Clearly, planning refers to decision making; (the other management tasks as well as a combination of organization and control decisions are reviewed.)

In the Operational research, the decision making issues are addressed in a systematic process. This process has the following steps:

1. Defining the problem
2. Identifying possible alternatives
3. Evaluation of possible alternatives
4. Select alternatives

The decision making is one of the duties of directors to resolve the problem or issue. So, if the problem does not occur, the decision does not need to be made by managers. Each problem has dimensions and definitions that should be expressed well-versed. After defining the problem, the possible alternatives for the problem are identified. By testing known alternatives, the best alternative is chosen by the director.

3.4. Models in OR

Using the models, especially mathematical models, is the basis of the OR. Model is a simplified or abstraction of reality. Models are usually simple version of reality; because often the reality of case has lots of complexity. Reflecting the complexity of problems in all aspects is very difficult and often impossible. Properties "simplification" and "abstract" in the OR models make it difficult in order to achieve the real goal. In other words, a simple model cannot express the actual status of the problem.

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3.5. The Application of Computers in the OR

Incredible advances of computers, is one of the key factors in the rapid progress of the OR. The complex and difficult issues which often OR dealing with, require a lot of calculations. Often do these operations manually is not possible. As a result, the computational capability of computers which is millions of times faster than manual methods, results in an extraordinary rapid progress in this science.

The progression of computer has paved the way to solve complex problems in the OR. Although only a few software were released in 1984, already it has been said that the underlying number of efficient software of OR is over 100. Growing OR software has caused OR techniques from theory become closer to practice and their scope is stretched more to businesses and industries more than before.

3.6. Operational research Approach to Problem Solving

The main feature of OR techniques and its emphasis is on systematic and logical approach to problem solving. It is through these techniques that its features are introduced as "scientific method".

3.6.1. Observation

The first step in the process of Operational research is to define the existing problem in the system or organization. Each system is constantly exposed to the problems that prevent the system from reaching its goals. Director must have some experts to observe the personnel and their relationships in order to achieve organizational pathology and problem's definition.

3.6.2. Defining the Problem

When it becomes clear that the problem exists, it must be carefully and clearly defined. Inaccurate and unclear definition of the problem could lead to the wrong answer. So the accuracy of defining the problem and the degree to which the problem can affect the performance of organization, is necessary to define.

3.6.3. Build a Model

Model in Operational research is a summarized expression of problem in the real world or organization. The model can be expressed in the form of a figure or graph. But often in the OR, the model consists of a set of mathematical terms. Mathematical terms of model in OR contains numbers and symbols. For example, suppose a commercial institute wants to sell goods. The production cost is 5 riyals and the selling price is 20 riyals. The model which expresses the total profit from the sale of goods, is:

Z-20X-5X

In this equation, X represents the number of sold products. And Z is the total profit from the trade. Symbols X and Z are read variable. It is clear that there is no pre-defined values for the X and Z, and it is the reason why the term variable is used. The number of sold units X and the total earnings Z can take any amounts in pre-defined domain; in other words, they can change. These two variables are completely separated. Variable Z is a dependent one; due its value dependency on the number of sold units. Variable X is an independent one; because the number of sold units in this equation does not depend on anything else. An equation in its general case is known as a functional relationship. Equation is also called relationship. The term is derived from the fact that the profit of Z, is a function of the number of sold units in X, and this equation, attributes the profit to the sold units.

Suppose now that the product is made of Iron and the institute has 100 kg. To produce each unit of product X, 4 kg of Iron is necessary. A new formula for the expression of the Iron product defined as follows:

$$100 = 4X \text{ Kg} \qquad (١)$$

Equation expresses the fact that every single product will consume 4 kg from 100 kg available Iron. Thus, the model consists of two equations as follows:

$$Z = 20X-5X \qquad (٢)$$
$$4X = 100$$

The profit equation in the above-mentioned model is called objective function. The term of consumption of goods from Iron is said a restriction. In other words, the institute is trying to maximize its profit as much as possible, and increase its profit as much as Iron availability allows. The increase in profit is limited to available resources (100 kg Iron). According to the expressed concepts, the two above-mentioned equations can be stated as follows:

$$\text{Maximize } Z = 20X-5X \qquad (3)$$
$$\text{Subject To:}$$
$$4X = 100$$

The above model is translated as follows:

$$Z = 20Z-5X \text{ maximize} \qquad (4)$$

Provided that:

$$4X = 100 \qquad (5)$$

From now on, for writing models, instead of English words, the following summary is used:

$$\text{Max } Z = 20X-5X \qquad (6)$$
$$\text{Subject To:}$$
$$4x = 100$$

This model represents a management problem that is going to determine the number of production of its institute. So the variable X, expresses the potential decision of the directors. So X is known as the decision variable. After completing the model, it must be revised to check if it is indicative of the operating system. Administrator shall ensure that the built model, is to represent the actual behavior of the system.

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3.6.4. Solving Model

The problem which is formulated in the OR form, must be resolved by the OR model-based and techniques. Each of Operational research techniques are used to solve a particular model, so this type of model and its solving technique are two distinct parts in the OR. It simply can be distinguished whether the built model would be solvable or not. Given that the model represents the problem, then it means solving the problem is of manager's interest.

3.6.5. Implementation Results

Problem-solving techniques in the OR provide information that will assist managers in better decision making. The manager should not use the results of the model without considering deep thinking. In the final decision making, managers need to combine information obtained from solving the model and with their experiences and consultants. If the administrator does not apply data obtained from the OR techniques, he should actually forget about all the steps in the OR scientific process. Scientific study will be valuable as soon as it will be carried. The actual value of scientific study process and its impact on system performance will be studied.

3.6.6. Repeatable Nature of OR Process

The completion of the OR Quintet steps of the process does not necessarily mean the process is completed. Maybe in every step of modeling, solving and implementing the necessity of revision is aroused. For example, in many cases, during the production of the model, new aspects of the problem may be recognized or that the resolution of the model and its implementation need to change their structure and define the case again. So at each step, getting feedback is required. Also the new information obtained from the environment and the future of the organization may affect the entire structure of the case and the model.

3.7. Operational research Applications in mechanization

3.7.1. Determining the Optimal Index Level of Mechanization

For the assessment of mechanization condition, indicators such as the level, Degree and capacity of mechanization are used. Of these indexes in different regions are different, depending on climatic conditions, soil texture and product type. Therefore, the plan for achieving stable development must be done, based on the desirable level of these indicators. In Operational research science, by modeling of the real situations and considering the limitations, the optimal index level of mechanization can be determine And on this basis, the next steps of planning and implementing development projects of mechanization should be taken.

3.7.2 Determining the Best Combination of Power Sources and Available Machines

Sometimes diversity in agricultural machinery market is to the extent that the decision about choosing a machine is difficult for farmers. Despite the factors such as technical issues, Price, machine's brand, the amount of credibility among consumers, regional adaptation and after-sales service makes, choosing a machine is not an easy task. On the other hand, in many cases, the aim is not merely buying an agricultural machine. But in cases where the farmer wants a set of devices (from tillage to harvest) and resources that can be purchased from a technical point to be matched, the complexity of the selection process will be added. By using science of Operational research and linear programming, and also quantifying these factors, the optimal combination of desired machines can be prepared and based on it, the machine was purchased or leased.

3.7.3. Planning for Mechanized Operations Due to Farming Calendar

In agriculture, unlike industry, activities are done in certain periods of the year. Due to time constraints in implementation, it is required prior to the provision of machinery to be seen in terms of quality and quantity of work has done at the proper time. The weather conditions may reduce the number of available days. Science of Operational research, raising the possibility of studying influential parameters (parameters such as time, the economic and technical issues which are contributing to machinery operations) by presenting a linear programming problem. After considering all these issues, the best plan for operation of mechanized farming units is offered.

3.7.4. Planning Repairing and Maintenance Operations of Machinery

Technical health and standby of agricultural machinery in the season, is one of the machinery principal tasks. Achieving this goal depends on the accurate and regular maintenance and repairing tasks. Operational research provides conditions under which with regard to technical, economic and time parameters, a regular and thorough maintenance and repairing process is planned in a way that, it has the lowest time and cost and best quality.

3.7.5. Planning to Buy a New Machines and Replacement

Lifetime of an agricultural machine depends on working hours, mode of operation of the device, and the arrivals of the new technologies to the market. The responsibility of machinery principal is to attempt to do replacement and modernization before spending more of their income on each of machines. Factors such as income, cost and technical issues can be imported into the economic model by economic modeling which is a part of Operational research science; and also the best time can be determined to replace the machines.

3.7.6. Reduction of Mechanized Unit Costs

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Starting and maintaining a business depends on its productivity. Profit comes from a simple but very practical equation which is the difference between the income and cost. By identifying sources of cost and also financial management, costs can be reduced and profits increased. The objective of application of science of Operational research, particularly in economic issues, is maximizing the positive factors such as income and minimizing the undesirable factors such as the cost. On the other hand, one of the reasons that mechanization is lagging behind in many parts of the world, is its cost, in a way that farmers will earn more profits by means of traditional agricultural activities. By using knowledge of Operational research and creation of an economic model for mechanized agriculture, an appropriate planning action can be taken in order to optimal use of the production, especially the machinery. In this way, the economic costs of mechanization can be reduced, and it is a great step in the development of mechanization.

CONCLUSION

Over time, the definition of agricultural mechanization has changed. Once, only using the tools and machinery, was considered as an indicator of mechanization. But now, paying more attention to other aspects such as management and software are considered as an important part of the development of mechanization. Knowledge of Operational research in comparison to the other sciences is new, but according to its ability, succeeded to find its place shortly among other industries; so that today this knowledge is used as an indicator of modernization for a commercial unit. The main advantage of this knowledge is that where many variables and constraints are involved in decision making, with the benefit of Mathematics and Modeling, it shows the optimal which facilitates decision making and reduces risk of an economic activity. Agricultural mechanization that also subjects to various factors such as technical, economic and social issues, needs the powerful device such as research operations to help managers in their strategic planning.

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Using Integer Programming To Optimum Harvesting
(Case Study: Shafaroud Forests)

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Abstract:
Most Costs for operating the forests are related to wood extraction from cutting areas and carrying it to the forest roads. Allocation of skidding machines should be done in such a way that total cost of wood extraction would be minimized. In this study, four skidding machines in operated parcels have been studied in series two of Nav, Asalem. Using the timing model, unit cost of each machine was calculated in different skidding distances. The output analysis of linear model based on zero-one integer programming showed that in plains slopes standard tractor and in the higher slopes Timberjack is more efficient.

Keywords: Skidding Machinery, Timing Models, Unit Costs, Optimum Allocation, Integer Programming.

1. Introduction:

Seven percent of Iran (12 million acres) has been covered by woodland that only 8/1 million acres (15 percent) of the total forest areas are including commercial forests (Esmaeilnejad, 2010). In forestry projects, road construction and transportation and extraction of woods are considered as the important elements thereof that require careful planning.

The largest part of the annual budget for every forestry project is allocated to the costs spent in this section and costs much capital for the executor. Hence, researchers were always looking for methods or approaches that could minimize the total cost of this section, however, would achieve their objective that is wood extraction from forest and raw material supply for industry sectors (Najafi, 2004).

Operation is the most important factor effective on costs in forest production system. This section also determines the costs and revenues as well as the amount of future production of the forest. What is remarkable is that, most costs for operating the forests are related to wood extraction from cutting areas and carrying it to the forest roads, because natural diversity of forest (slope, elevation, soil, climate, etc.), various machineries and operating systems and their heavy costs all on one hand, and considering market requirements and associated limitations thereof, on the other hand, has made operation a wide and complex activity. The volume of wood that is harvested from a series each year is limited as well (Najafi, 2004). Linear programming is defined with a set of independent variables which are offered as outputs of the model.

2. Timing Models

In order to study wood extraction from the cut-off areas and carrying it to the forest roads through the skidding machines, time studies are used. In this method, first, the important factors in execution of skidding operations are discussed. By implementation of perfectly random timing in the area, the mathematical model to predict time for fulfillment of work is provided using a computer statistical system. In general, after the importation of each machine into country, the mathematical model of function and cost of production has been studied by investigators. In these models the mathematical relationship between the operation of machine and the dependent variables has been shown (Najafi, 2004).

Variable of timing models are skidding distance, linear slope of skidding path, value of logs at every transporting turn, winching distance, volume of load in cubic meters, the length of logs, etc.

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3. Research Background

Murray and Church (1994) used random solution to plan and manage forest and offered three solutions. They predicted an important application of mathematical programming in southern Sweden on 8 companies based on private funds as well as identifiable and non-identifiable costs on the basis of shadow cost. Change et al (2009) used the Analytic Network Process and goal programming for revitalization strategy and transportation of raw materials. The main purpose of their studies was to use Fuzzy Delphi to solve the problems of revitalization. Fotakis et al. (2012) used spatial genetic algorithms for multi-purpose planning and objectives to increase volume of logs harvesting and reduce the sediment. They considered the rate of log production as a restriction.

Philippart et al. (2011) used mathematical formula and exact solution for spatial problem of dragging logs in tropical forests, that optimal improved road network to reduce structural costs and improving resource management was necessary. Karahalil et al. (2009) used linear programming to protect soil, water resources and values of logs production in forest management project. In management model based on linear programming and solving it with Lindo software, 6 programmable solutions were proposed. Alvarez and Vera (2011) applied robust solution to solve the problem of saw mill and timber processing.

Ohman and Errikson (1998) used mathematical and innovative methods to prepare the road network and utilization chart.

Duangsathaporn and Prasomsin (2004) examined the use of linear programming for forestation. Results of the model were evaluated and in an irregular iteration, management program for maximum values was explained so that irregular mass was transformed to regular mass in final period and at the end of horizon of the Program, distribution of classes was managed in such a way that operation of logs per period or per year could be fulfilled equally.

Ghajar et al (2010) used fuzzy theory to allocate carrying machines and spatial locating. Three separate fuzzy models were used to predict the cost of wood processing for each machine, then appropriate machine was assigned. His subjected carrying machines were 3 machines of Timberjack, HSM and Zetor in a mountain forest.

Naghdi and Mohammadi Limaei (2009) achieved the optimal density of forest road based on the cost of road construction and distance of wood processing in the forests of northern Iran using linear programming and with the aim of determining the lowest transportation cost and specifying the most appropriate skidder for the average distance of processing. Results showed that the lowest cost is for the Clark skidder. Optimal density of road in this study was 8 meters per hectare.

Kazemi (1998) presented the best combination of machineries considering the harvest volume in the parcel. He showed how much cost and time did each machine require for wood extraction from the intended parcel.

4. Materials and Methods

Series 2 of Nav which is in Dist. 7 of northern forests, has been located between longitudes of 48° 44’ 36” - 48° 49’ 58” and longitudes of 37° 37’ 23” - 31° 42 37 (geographic coordinates). Average annual rainfall of the region is about 848 mm and the maximum and minimum values are respectively 1142 and 651 mm. An important issue in this part of Landtype report is the rate of stability of fields of studies which are too important in programming, because important events such as landslides and landslide are the major problems for these areas and mechanical measures including road construction and nonstop cutting across the forests contributes to this issue, i.e. rate of mudslides. Type of soil is mostly brown forest soil with acidic PH.

For this study, the parcels of 64-65-66-67-68-75 were selected which were used for operation in year 2012.

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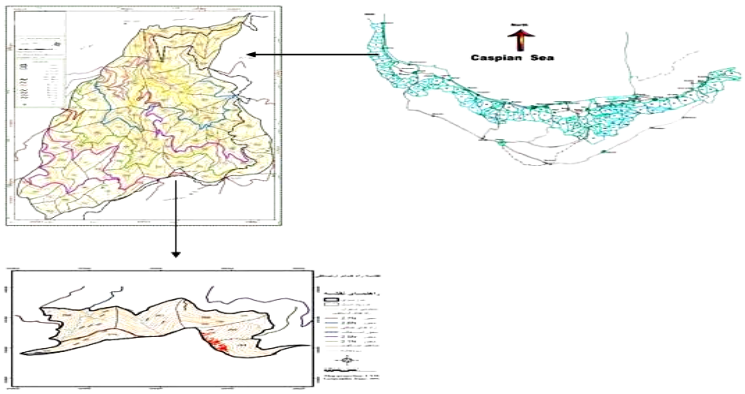

Figure 1: Location of the study area

5. Timing Models and Hourly Costs of the Studied Machineries

Skidding machineries and timing models which have been considered for this study include:

Timberjack C450 , HSM904 ,Zetor, Standard tractor , Komatso D-66

T=2/52+0/0273 **D** +0/485 **SW** + 0/601 **N** + 1/24 **V** (1)
T= 3/85 + 0/0346 **D** +1/47 **V** (2)
(Naghdi et al, 2010)
T= 0/02**D** +6/04**V** +0/92**S** (3)
T= 0/024**D** +0/986**S** (4)
(Guilanipour, 2010)

That in these equations, T is the time of a skidding turn per minute, D skidding distance in meters, N number of logs at every turn, S skidding slope, SW slope of winching, V the volume of logs at every turn.
Since timing models used were selected out of researches conducted in the same year, thus they became the basis for calculations. Hourly fee of Timberjack, Zetor, HSM, standard tractor and Komatso in 1389, was 650,976.—Rls., 265,675.—Rls., 720,464.—Rls., 130,856.—Rls., and 267,417 Rials, respectively. As can be seen HSM has the highest hourly fee and standard tractor has the least hourly time in the above year.

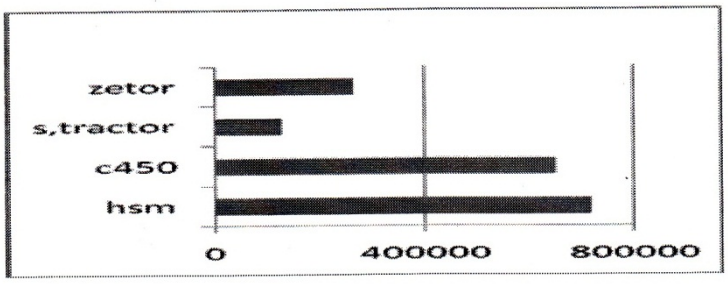

Figure 2 - Comparison of hourly fees

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Time is one of the limiting factors in the economy and more profit. Time is an important factor in promoting economic plans and has always been considered as important cases in the science of programming. In this research, to build models, for determination of the costs and hourly production of every skidding machinery, in distances and classes of the studied slope, for the first step, we calculated the sweep time towards the cut location for each machine. To calculate the time of each cycle, first due to timing models, we placed the available variables in the model considering the circumstances, then, we proceeded to calculate the cycle time. Limitation of slope and amount of load carriage for standard tractors were among things that were considered for this study. Since standard tractor is used in plain areas and up to 20% slope, this machine is not efficient in slopes exceeding 30%. Also, because of underlying skidding distance and its importance in timing models, we considered the base table for making model according to the average slope of the two floor area by 15% and 45% intervals of 100, 200, 400, 600, 800 and 1000 meters, the deployment of. Extraction fees of logs per square meter in skidding distances and slope classes were obtained out of multiplying the carrying time spent per hour by the volume of output woods. Then, programming model was made. Zero-one model is the minimum of the objective function, provided that in each column of the primary table or in other words in average skidding distance, we would choose the most optimal machine.

$$\text{Min} \sum_{j=1}^{m}\sum_{i=1}^{n} CiXi$$

s.t

1) $x1, x2, \ldots, xn >= 0$

$$\textbf{2)} \sum_{i=1}^{n}\sum_{j=1}^{m} Xi = 1$$

Since this model is based on minimizing the unit cost, it is affected by the hourly fees and cycle time of each machine.

Restrictions:
Non-negative variables
Allocation of a machine to each skidding distance and slope class

Solution of the Model using Lingo Software:
A program in Lingo starts with the word “Model” and ends with the word “end” and usually is composed of two parts: The objective function and constraint

Output Analysis:

• **Value**: shows the value of variable in the optimum solution of linear model.
• **Reduced Cost**: coefficient of variable in row zero, represents the optimum solution.

6. Results:

Comparison of model parameters in this study, deals with investigation on the changes towards skidding distance, increase of slope and quantitative comparison of the parameters in each machine with other machines. Skidding distance and average slope of the field are in direct proportion with time of each cycle and unit costs.

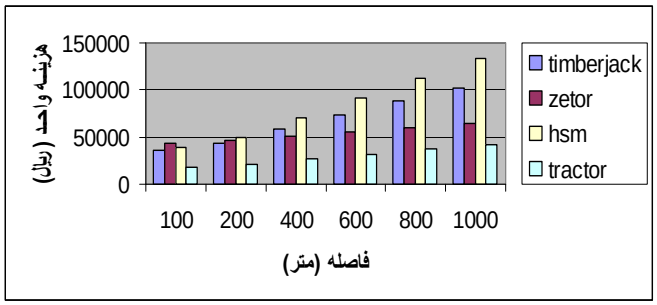

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Figure 3 - unit costs in plain slopes

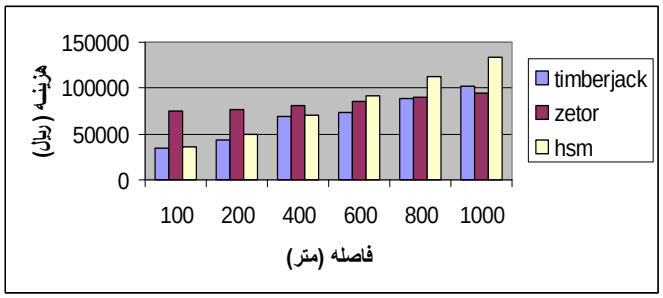

Figure 4 - unit costs in higher slopes

The model built in this study aims to minimize a cubic meter of wood extraction. In fact, in objective function the total cost were minimized and the base modeling table was used to formulate. Parameters described were calculated based on this table
.

Table 1 - Output of null and one model after 12 Reiterations:

Global optimal solution found at iteration: 12

Objective value: 579678.4

Variable	Value	Reduced Cost
X1	0.000000	17300.10
X2	0.000000	22059.00
X3	0.000000	31577.00
X4	0.000000	41125.00
X5	0.000000	50826.90
X6	0.000000	60375.30
X7	**1.000000**	**0.000000**
X8	**1.000000**	**0.000000**
X9	**1.000000**	**0.000000**
X10	**1.000000**	**0.000000**
X11	**1.000000**	**0.000000**
X12	0.000000	7987.500
X13	0.000000	25508.00
X23	0.000000	2405.500
X24	**1.000000**	**0.000000**
X25	0.000000	20805.00
X26	0.000000	28567.60
X27	0.000000	44092.80
X35	0.000000	24419.10
X36	0.000000	38327.00
X37	**1.000000**	**0.000000**
X38	**1.000000**	**0.000000**
X39	**1.000000**	**0.000000**
X40	**1.000000**	**0.000000**
X41	1.000000	0.000000
X42	1.000000	0.000000

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In output analysis of this model, it was found that in all studied distances in the plain slopes the standard tractor and in higher slopes, Timberjack skidders could be economically optimized.
Table 2 - Response Variables in Output Analysis

Average Skidding Distance	100 m	200 m	400 m	600 m	800 m	1000 m	100 m	200 m	400 m	600 m	800 m	1000 m
Average Slope of the Field	15%	15%	15%	15%	15%	15%	45%	45%	45%	45%	45%	45%
Skidding Machine												
Timberjack	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
Zetor	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24
HSM	X25	X26	X27	X28	X29	X30	X31	X32	X33	X34	X35	X36
Standard Tractor	X37	X38	X39	X40	X41	X42						

Application of Reduced Costs in Optimization:
As it can be seen in the output of this model in the Table, in average skidding distance of 1,000 meters and an average slope of 45% area, Zetor machine is optimal. Since Zetor is not technically efficient in the distance, we use the advantage of reduced cost to find optimal option. In the corresponding column, three skidders of Zetor, Timberjack and HSM entered the model. In Lingo output column, the number 7987/5 for Timberjack, and 38327/00 for HSM have been specified. According to the definition of reduced costs under these conditions, Timberjack which has a lower numerical value is more efficient.

Discussion and Conclusion:
Study on the cost of machineries and planning to locate them as well as investigation on hourly fee, will help the planners to select the optimal system for prioritizing their application. Wheeled and chain skidders such as Timberjack, HSM904, Zetor and Standard Tractor are among the most important skidding machines in mountainous forests in Northern Iran which are used in different skidding conditions.
Linear programming model is as a useful tool for resource allocation and by offering analysis greatly helps in deciding the scarce and limited resources (Kazemi, 2000). Using Lingo software also enjoys high speed and accuracy in data analysis and extraction of information required for the final analysis and for the management of production, especially when large amounts of data are considered.
However, in the research conducted, reviewing the conditions of existing machines, it became clear that in current situation for forests of Shafaroud district, wheeled skidder are also used in slopes over 35 percent. Although these machines are designed for slopes less than 35 percent, however, due to the speed and suitability of the conditions of the forests in Guilan Province, in the present circumstances, it is the best option for managers and executives of the project. Also for the realization of sustainable development policies for the operational affairs, it takes fewer funds, and therefore, they do not have the purchase of new and up-to-date machinery in their operational plans and this has led to use Timberjack skidder in slopes higher than 35% as well.
Since the operational skidder machines have been imported, first, we must import machinery ensures the highest performance with the condition of our forests in the north of country so that among the technically efficient machines, the most economical ones would be imported (Kazemi, 2000). It is recommended that, when renting machines from other companies enough attention would be paid to the hourly fees (Kazemi, 2000).
It is suggested that this planning method would be used to determine the type of skidding machinery in order to reduce

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wood extraction costs in other forest areas of north of the country.

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Studying the effect of freezing on artificial ripening of 'Mazafati' date fruits in Khalal stage

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Abstract−The palm bunch wilt or date bunch fading disorder (fruit shriveling and desiccation before ripening) and fruit abscission due to high weather humidity or strong local winds blowing have forced the palm owners to harvest the date fruit yield in Khalal stage and ripen it artificially, so that they may reduce the loss to a remarkable extent. The present research studies the application of the method of freezing and keeping refrigerated for artificial ripening of date fruit at Khalal stage. This experiment was carried out in a factorial manner and in form of randomized complete block design. The experiment included two factors that are 1) ripening stage in three levels (Khalal, semi-ripe, and Rutab), and 2) storing time in three levels (45, 90, and 135 days). After being stored in the freezer, date fruits at Khalal stage were taken out of the freezer in the related times and required tests in regard with fruit water content, pH, reducing sugar percentage, total sugar percentage, Total Soluble Solids percentage (TSS), and titratable acidity were performed on them in the laboratory. Results indicated that, after keeping fruits refrigerated, percentages of Total Soluble Solids percentage and total sugar percentage were significantly increased over time. Percentage of reducing sugar was lower in Khalal stage in compare to Rutab stage. Acidity and moisture content in Khalal stage were higher than in Rutab stage. Color of fruits in Khalal stage stored in a refrigerated condition turned darker over time, and the fruits tissue became softer, to the extent that they were marketable after 45 days. The more the storage time is prolonged, the more the fruits turn darker and softer. However, the quality of the fruits stored and marketed in this method were as the same as the newly-picked fruits.

Key words−Artificial ripening, Date, Freezing, Khalal stage, Mazafati cultivar, *Phoenix dactylifera* L.

I. INTRODUCTION

Mazafati date is one of Iranian high-quality dates. This date is known as the predominant trade date of Kerman Province, as 90% of orchards of Bam area, and about 60% of orchards of Jiroft & Kahnooj areas are allocated to this cultivar. Living and economic status of residents of these regions is depended on this date, and thus, any problem affecting production of Mazafati date, would finally affect the region's and the peoples' economy. One problem from which the palm owners are suffering about 15 years is palm bunch wilt of Mazafati date. In this disorder, the petiole turn black in the beginning of Rutab stage, and fruits loss their water and become shriveled and finally desiccated. Damage of bunch wilt in young trees is so heavy and,

in some cases, it even reaches 70%. Since ripening time is not the same for all date fruits in one bunch, harvesting during Rutab stage is done in several turns (about 4 to 5 harvest turns), and it is one of the critical and expensive

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the fruit gets overripe and fall in the result of rainfall in late summer, causing irrecoverable losses to the palm owners. Some experiments have been already performed, however a definite solution for this problem has not been found yet. Thus, any measure taken towards reducing the damage would be a help for the palm owners since the livelihood of some palm owners is quite depended on Mazafati date. Accordingly, a method for ripening the date artificially in Khalal stage is sought as compensation for lack of a definite solution in this regard. Date palm (*Phoenix dactylifera* L.), is a dioecious specious, of Monocotyledones category and belongs to Arecaceae family. The growth of date fruit includes 5 stages that are 1) Hobabook, 2) Kimri, 3) Khalal, 4) Rutab, and 5) Tamar.

Ancient Egyptians, without being aware of advantages of increased ethylene production, used to apply these advantages for stimulating the ripening through Egyptian unripe cut figs. In the recent years it has been found that ethylene regulates fruit ripening. Ethylene is gaseous in

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standard condition and its effects have been known for more than one century. However, this product has been recognized as a hormone not longer than since 1960. This gas is one of the natural ingredients which produce during fruits ripening process. In an experiment, foliar application of ethephon with concentrations of 0, 1000, and 2500 mg per liter were performed on bunches of Hayyani date cultivar 123 and 136 days after fruit formation. The results showed that this way the fruits ripening may be accelerated up to 4 to 16 days. In higher concentration of ethephon, the rate of reaction was increased; also, treated fruits were richer in free amino acids and total sugar content and had lower amount of tannins in compare with control fruits [10]. Shahani date cultivar was treated by ethephon with concentrations of 0, 125, 250, 1000, and 2000 mg per liter for two minutes at dates of three harvesting times. Application of ethephon in this treatment significantly increased respiration and acidity. Total soluble solids percentage, fruit tissue firmness, astringency, pH, and dry weight of pulp and seed were affected by the harvesting dates, but they didn't react to different concentrations of ethephon [12]. Using vinegar for date ripening is a common method in Spain. Since growth of the date fruit is stopped in Khalal stage in this region and, on the other hand, the fruit is not edible in this stage, vinegar is used to continue the ripening process. In this method, after harvesting the fruits in Khalal stage and treating them with foliar application of vinegar, the fruits are stored in sealed containers for one day; when the dates are removed from the containers afterwards most of them have turned into Rutab. Similar methods of ripening dates in Khalal stage on Hayyani and Samani cultivars have also been reported [7]. In another experiment, Mazafati date cultivar was harvested in late Khalal stage from a commercial orchard located at Bam area, and then treated by sodium chloride 2%, acetic acid 2%, and combination of both of them which significantly led to increased total soluble solids and decreased fruit tissue firmness and fruit water content. The best result obtained by applying acetic acid 2%, yet the fruits treated by sodium chloride were of higher quality in regard with their appearance. In both experiments, exposing the samples to temperature of 38-40ºC and relative humidity of 85-90% for a period of 3 days significantly accelerated the ripening, increased total soluble solids and decreased fruit pulp firmness. The treated fruits were of desired quality and marketable after 3 months from the storing launch. Generally, it was concluded that harvesting the date fruit from mid to late Khalal stage, treating it by sodium chloride with concentration of 2% after rinsing and disinfecting it, and storing the treated fruit in temperature of 38-40ºC and relative humidity of 85-90% for 72 hours is a rapid and economical method for artificial ripening of Mazafati date [13]. One of proposed methods for artificially ripening date fruits is freezing date fruits at Khalal stage and then heats them. By freezing, ice crystals are formed and cell wall is torn up, resulting in creation of a free outlet for enzymes and other fruit ingredients whilst melting which in turn leads to accelerated ripening [6]. In Iraq, it has been found that the method of freezing and melting for accelerating Hallavi date cultivar ripening in Khalal stage is more effective than thermal and chemical treatment [4]. In America, before heating, fruit is placed at temperature of -27ºC; then it is exposed to a higher temperature for 32 hours and is stored in the refrigerator thereafter [3], [5], [9], [11]. Khanizi date cultivar is one of Bahrain's cultivars for which a desired condition may be provided to ripen it using freezing. This way, ice crystals are formed during freezing which tear the cell wall up; whilst melting, the cell extract is exuded along with enzymes and other fruit ingredients resulting in fruit tissue softening. In this status, water content of Khalal is about 50-60% which softens the tissue to the extent that makes any transportation difficult. To solve this problem the temperature of 50ºC may be used for drying and moisture-decreasing [1], [2], [3], [11], and [15]. An experiment carried out in Hormozgan province on ripening Khanizi date cultivar in Khalal stage using NaCl solution, acetic acid, and freezing method, and also storing in temperature of 40-70ºC with adequate humidity, revealed that the best treatment is freezing and then storing in temperature of 50 ºC for 48 hours [14].

II. MATERIALS AND METHODS

In August 2011, five trees of date palm, Mazafati cultivar, were selected from Azizabad agricultural research station of Bam area, and their fruits were harvested as follows: Mazafati date fruits were harvested in late August with three forms: Khalal stage, semi-ripe and ripe (Rutab stage); in a manner that in each stage 50 fruits were harvested from the trees in 3 replicates, and then were stored in freezer in temperature of -7ºC after being packed.

The experiment was carried out in a factorial manner and in form of randomized complete block design. The experiment had two variables including: ripening stage in

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three levels (Khalal, semi-ripe, and Rutab) and storing time in three levels (45, 90, and 135 days). After being stored in the freezer, fruits at Khalal stage were taken out of the freezer in intervals of a month and a half and in three steps (45, 90, and 135 days), and required tests in regard with fruit water content, pH, reducing sugar percentage, total sugar percentage, Total Soluble Solids percentage (TSS), and titratable acidity were performed on them at the laboratory of Kerman agriculture and natural resources research centre. Analysis of Variance was performed on statistical data using MSTAT-C statistical software, and means were compared by Duncan's multi-dimensional test at the probability level of 5%. whereas, after taking the fruits out of the freezer in each step, they were exposed to room temperature of 25 ºC for 5-7 days and the changes were then recorded.

III. RESULTS AND DISCUSSION

Based on the results of the variance analysis (Table 1), the effect of ripening stages on Total Soluble Solids percentage of Mazafati date and, also, the effect of storing time on Total Soluble Solids percentage, are very significant (1%). Means comparisons presented in Fig. 1-2, indicated that percentage of Total Soluble Solids in Rutab stage is higher than in Khalal stage, that is, the rate of Total Soluble Solids is downward from Rutab stage to Khalal stage, and it is increased over time in freezer or fridge. Yektankhodaei (2006) observed a fluctuation of 36–40% in Total Soluble Solids in method of ripening at Khalal stage of Khanizi cultivar by freezing and then heating it in presence of adequate humidity [14]. In his experiment on artificial ripening of Mazafati date, Golshan (2005) observed that the highest rate of Total Soluble Solids was related to the date fruits ripen on the tree (control fruits), and that the fruits treated by sodium diacetate solution were in the lowest level in regard with these ingredients [8].

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Table 1: Analysis of variance effect of ripening stages and storing times, and their interaction effect on different characteristics of Mazafati date fruits

Change resource	d.f.	Means of squares					
		T.S.S.	T.A.	pH	Reducing sugar content	Total sugar content	Water content
Replicate	2	40.373	000.0	0.042	11.51	7.06	4.83
Storing time (A)	2	179.45**	0.36 ns	0.25**	39.02 ns	649.86**	8.98 ns
Ripening stage (B)	2	293.45**	1.08*	0.038**	40.30 ns	50.84 ns	225.38**
A× B	4	35.65 ns	0.36 ns	0.054**	61.31 ns	70.905 ns	17.59*
Error	16	29.46	0.37	0.009	99.02	48.82	6.47
cv		9.74	19.04	1.32	24.9	16.63	6.67

ns: not significant; *: significant difference in level 0.05, **: significant difference in level 0.01

Based on the results of the variance analysis (Table 1), the effect of storing time on the total sugar percentage of date fruit was very significant (1%), but the effect of ripening stage on total sugar percentage of date was not significant. Means comparisons presented in Fig. 3-4 indicated that, by increased storing time, total sugar percentage is primarily reduced over 90 days, and then starts increasing over 135 days. This, despite lack of any significant differences between the ripening stages, shows a total increase in total sugar percentage of fruits at Khalal stage in compare to Rutab stage. In method of ripening Khalal of Khanizi date cultivar, Yektankhodaei (2006) demonstrated that there is a significant difference in the mutual effects of freezing and heating in the initial brix of 36 (5%), and that the applied treatment results in increased total sugar content [14].

Based on the results of the variance analysis (Table 1), the effect of storing time on the reducing sugar percentage of Mazafati date, and also the effect of ripening stage on reducing sugar percentage of Mazafati date are not significant. Fig. 5 showed, the reducing sugar percentage is initially increased in semi-ripe stage, and then it is reduced in Khalal stage. The means comparisons presented in Fig. 6 indicated that, by increased storing time, the reducing sugar percentage is initially increased over 90 days, and then starts decreasing over 135 days. Golshan (2005), in his experiment on artificial ripening of Mazafati date, reported that the highest reducing sugar percentage was related to the date fruits ripen on the tree (control fruits), followed by the fruits treated with acetic acid, and the lowest reducing sugar content was related to the fruits treated by sodium diacetate [8].

Based on the results of the variance analysis (Table 1), the effect of ripening stages on pH and, also, the effect of storing time on pH, were very significant (1%). Means comparisons in Fig. 7 indicated that pH was in its lowest level in Rutab and Khalal stages and reaches to the highest level in semi-ripe stage. Means comparisons in Fig. 8 indicated that pH was in the lowest level within 45 days of storing, and reaches to the highest level over 90 days of storing. Means comparisons presented in the graphs indicate that, in Khalal and semi-ripe stages, pH were increased over storing time, in the other word, the fruit medium approaches from acidic state to alkaline state. In Rutab stage, due to some chemical changes and also due to water and moisture loss, pH reaches its maximum possible level [2], [14]. Golshan (2005) reported that pH was reduced after one and two months of storing, and then after four months it was increased [8].

According to the results found, applying the freezing method affects fruit color change and tissue softening of Mazafati date, significantly. After 45 days of storing, the more the storing time is increased, the more the fruit color is changed and the more the tissue is softened. The reason is movement of cell sap carrying enzymes including

Polygalacturonase and Pectinase, that results in conversion of protopectinic insoluble substances into simple pectins. Polyphenol oxidase enzyme changes tannin from a soluble state to an insoluble state, and removes the astringent taste of the fruit). Asif *et al.* (1983), Karla *et al.* (1977), Chata *et al.* (1985), Houck *et al.* (1980), and Shamshiri *et al.* (1998) reported similar findings in regard with applying acetic acid in date fruit ripening. Yektankhodaei (2006) also reported similar findings in

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studying the method of ripening of Khanizi date cultivar at Khalal stage by freezing and heating.

IV. CONCLUSIONS

In Khalal freezing method, date fruit quality is not affected; the fruit maintains its freshness when it is taken out of the freezer, and the fruit tissue quality is as the same as a date fruit at Rutab stage newly harvested from palm tree. However, it is recommended not to store Khalal-stage fruits in temperature of -7ºC more than 5 months, since such a condition is proper for micro-organisms' growth. For better storing, the temperature of -18ºC is recommended, although the process of fruit color change and tissue softening occurs in a longer time under this temperature. The fruits taken out of freezer in each storing step were stored at room temperature of 25ºC for about 7 days, and higher rates of tissue softening, color change and sweetness were observed thereafter. Since the fruit treated by such method has a lower level of reducing sugar content, it could be recommended to people with special diet like diabetic patients.

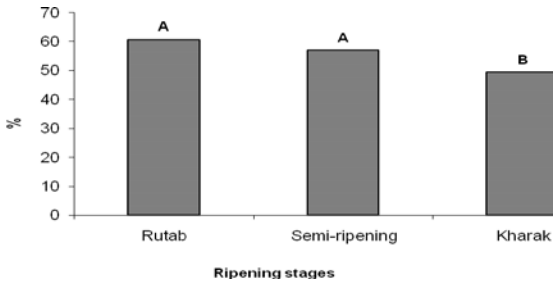

Fig. 1 Comparison between mean of ripening stages on total soluble solids percentage of Mazafati date fruits.

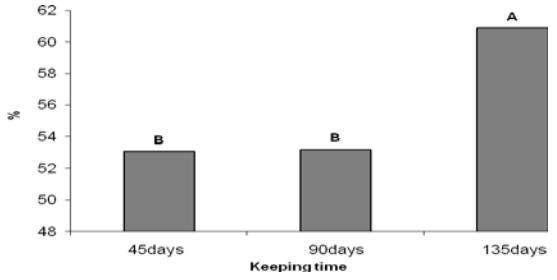

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Fig. 2 Comparison between mean of keeping time effect on total soluble solids percentage of Mazafati date fruits.

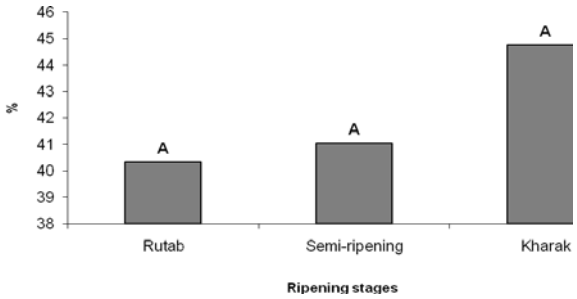

Fig. 3 Comparison between mean of ripening stages on total sugar percentage of Mazafati date fruits.

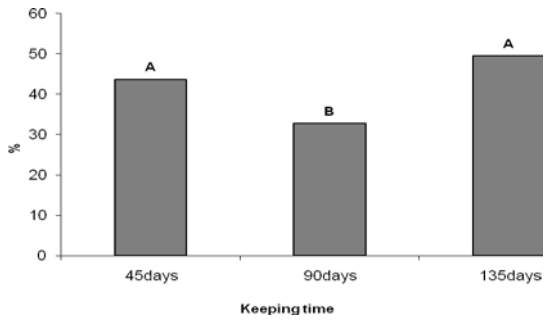

Fig. 4 Comparison between means of the effect of ripening stages of fruit on total sugar percentage of Mazafati date fruit.

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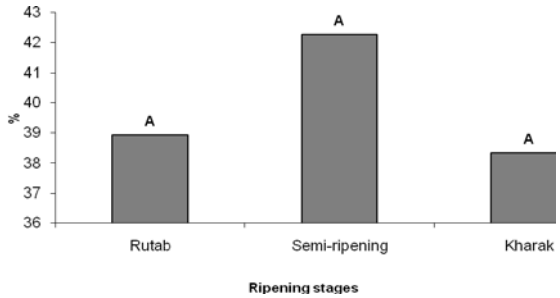

Fig. 5 Comparison between mean of keeping time effect on reducing sugar percentage of Mazafati date fruits.

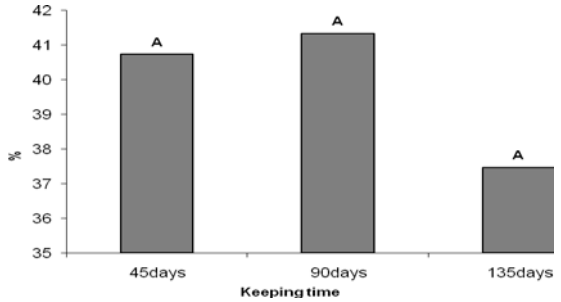

Fig. 6 Comparison between mean of keeping time effect on reducing sugar percentage of Mazafati date fruits.

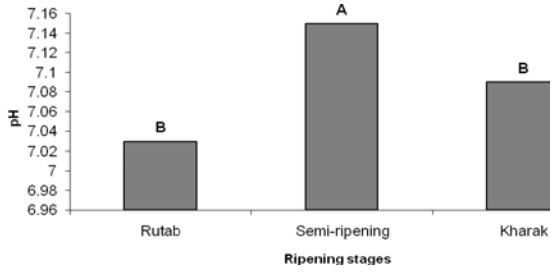

Fig.7 Comparison between mean of ripening stages on pH of Mazafati date fruits.

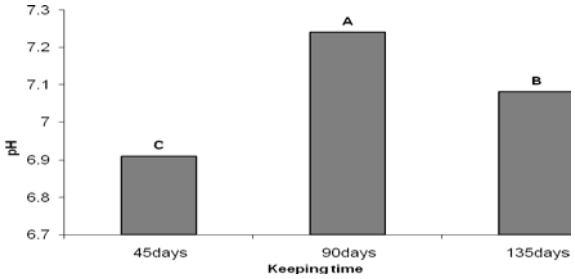

Fig. 8 Comparison between mean of keeping time effect on pH of Mazafati date fruits.

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Kat, an Architectural Invention for Temperature Adjustment in City of Dezful: Economic Architecture*

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Abstract: One of the outcomes of the ever growing technology and urbanization is the incessant flow of new architectural styles expressed in different structures and forms we have been witnessing every day. The question arises as of the mass of the architectural structures and monuments which one could be characterized and introduced as a sustainable and durable work? Most of the traditional buildings are characterized as *relatively sustainable* architectures, since in their construction a good tradeoff could be achieved for such factors as culture, originality, climate, local materials, and functionality. Sustainable architecture at each time involves harmony with environment with the least damage to nature, maximum energy saving, roots in local culture, as well as a proper response to overall functional requirements of readability and unambiguity. This study explores "Kat", a unique structure developed in an organic fashion along parts of the Dez River near Dezful city. The research is conducted based on a descriptive survey design where the required data is gathered through field observation, interview with local people, and library research. Our findings underline the highly adaptive and comfort seeking nature of human being which, in our case, is manifested in Kat thank to the benevolent presence of the adjacent natural rocks on the riverside. This place while serves as a resort, it satisfies the sustainability conditions *privacy*, *introversity*, *dynamism*, and *economy of the structure*) without adverse consequences for the natural environment.

Key words: Kat, vernacular architecture, sustainable architecture, economy of architecture, nature versus architecture

1. Introduction

Appearance of the North Khuzestan reliefs dates back to the Cenozoic Era. Its north-eastern parts during the orogenic revolution in the Tertiary Period have turned into a folded collection of Synclines and Anticlines which have been stretched along other Zagros folds. The rock type of these folds is of Marne (calcareous soil with clay, sand, gypsum, and salt) and deposits of the plane area have been created from these folds. In northern areas of the Dez River location towards Shushtar, a large alluvial fan (cone) is formed. The alluvium is mostly made up of gritty rubble, sand and gravel. In majority of the past synclinal periods, the Zagros Mountains due to development of the late Tertiary formations or the Bakhtiari Conglomera (related to the Cenozoic Era) the alluvium is of low thickness and at times in the plains, these strata appear as mounds. The maximum recorded thickness for plains is 200 meters. However, alluvial thickness in most of the plains is less than 100 meter (Ghahari, 2009: 46).

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The city of Dezful around 2600BC (five thousand years ago) was the Elamite capital called Avan. In the ancient scripts written after the Noah‟s Flood, it is referred to a city named Avan. Western archeologists, including Walter Hinz, the German expert who in his book "The Lost World of Elam" which is translated to Farsi writes, "Avan might have been in the place where Dezful city is now located."

The word *pol* (bridge) referred to the bridge constructed by Iranian and Roman engineers in the 4th century AD on the command of Shapour the First the Sassanid King to connect the new capital, i.e. Jondi Shapour, to Shushtar city. The name of Dezful or Dezhpol was originated from the mentioned bridge.

The world Dezful is the Arabic spelling of "*Dezhpol*" or "*Dezhpohal*" in Pahlavi; a combined word made up of "Dezh" meaning fort, fortification, or blockhouse and "Pol" equivalent to the word bridge in English language which together signify a fortified bridge, bridge fortification, or bridge blockhouse in which a number of guards are stationed (Fazeli, 2011)

In the book "Historical Geography of Khuzestan Territory", Ebn Sarabiyun writes, "Dezful means Dezhpol or bridge watchtower which is situated by the Dez River in the southern part of
the old city Jondi Shapour. It is believed that this city was built on King Shapour‟s decree and for this reason the city was given the name Jondi Shapour. In some books, it has been said that the river was formerly also called by the names "Zaab or Jondi Shapour". Some geographers and historians have applied the names Ronash and Ronash Palace to this city.

Dezful city is one of the largest cities of Khuzestan province with an urban and rural population of 221174 and 159242, respectively, in 2001-2002. Dezful city is the central city of Dezful county situated in the plains of north Khuzestan with a total surface area of 4762km^2 positioned between 48 degrees and 34 minutes east of the Prime Meridian for longitude, and between 32 degrees and 34 minutes and 8 seconds north of the Equator for latitude, and at 120m altitude above the sea level [7]. This city is located at 721km from Tehran and 160km from Ahwaz. It is bordered on the north by Ahwaz city, on the west by Andimeshk and Elam province. This county is divided into three districts, namely Central district, Choghamish, and Sardasht. The three districts together comprise the cities of Dezful, Safiabad, Dez Aab, Miyanrood, and Sardasht, and 11 rural districts and 717 small villages.

Average minimum and maximum humidity of Dezful on May and December is 16 and 67.5%, respectively. There is a predominantly southwest wind in the summer and therefore, you‟d better avoid using a grand opening in architectural project in this direction. Maximum annual rainfall in Dezful County, based on the last 15-year statistics has been 372.6mm on average and the average

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number of frost days (FD) is 4.2 days annually [7]. Being positioned at 33 degrees north latitude, a hot and humid climate prevails in Dezful County. The desirable condition for construction of building in this city is at 15 degrees southwest to 15 degrees southeast.

Kat is the generic name applied to a large number of the cavernous holes alongside the Dez River dug by man in the rocky conglomerate walls which have been formed as the outcome of an organic interaction between natural forces within the environment without any architectural plan, so as, originally, with only slight modifications at the hand of man they could be transformed into dwelling places.

This paper highlights the significance of the technically superb features thought out and adopted by humans 3000 years back in the history in coping with adverse natural conditions such as extreme heat. The research specifically explores an extraordinary resort place in Dezful city, called „Kat", and given the descriptive style maintained in this paper, it serves as an informative text, acquainting the reader with different aspects thereof. In the following, at the hand of two hypotheses the subject of this study is addressed in two different lights; the one emphasizes on the socioeconomic factors, whereas the other maintains a natural explanation for the understudy structure. Next, based on the proposed hypotheses, within a natural, historical, and cultural context, an inquiry is made into architectural features and dimensions of the structure in question, and the environmental determinants contributing to this phenomenon. Our findings from this fairly extensive analysis will verify relative validity of the stated hypotheses. In the final section, the concluding remarks and the key points are presented.

2. The hypotheses

First hypothesis: In talking with the local people, some of them ascribed the "Kat" to the use the guards of the subterranean networks called *Shabbadan* made of such space in the time. In the old times, Dezful inhabitants used the *Shabbadan* networks which reached out to the riverside as a safe passage against the unbearable heat of the region to get access to their daily required water and for their daily communication purposes. The houses of the Dezful city were all interconnected (intercommunicated) to each other via the underground networks ending up to the riverside.

Second hypothesis: The geometry of Kat is further developed from the cavity caused by the undulating and rapid current of water which heats the river"s sidewalls at each turn. Dez abounds with water and flows through many turns and twists, so as the rapid stream in the face of sudden shifts in its direction abrades the rocks at the riverside and as a result of long time erosion the Kat has been formed.

3. What are Kats?

Kats refer to a relatively large number of the cavernous holes or cavities alongside the Dez River shaped by humans in the rocky sidewalls mainly composed of conglomera and soil. This architecture is peculiar to city of Dezful, Khuzestan, Iran.

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"Kat" in early form was a cave-like space which gradually over an extended period of time has been developed into the present state as the local people built up knowledge and experience on this type of spaces. The much care shown by the natives for improvement of these spaces must be ascribed to the functions they used to have earlier as the sentry post, and later on as a shelter and refuge against the heat and a means of comfort. Today, apart from its traditional function by bidding shelter against the heat, it has found enjoyable recreational by offering a place to spend one"s leisure time where the visitors can rest and relax for some hours away from preoccupations and stresses of the daily life.

During the Imposed War (1980 – 1987 AD), "Kats" proved to be a safe and peaceful place for the inhabitants of this region. The latter functionality can give yet another incentive for further refinement of the place to the perfection.

It is noteworthy that all along the Dez River, "Kats" are only seen in two stretches. The two areas alongside the river which were favored by the early natives were exactly positioned in south-to-north direction with their back on to the sun, indicating deep insight of the former inhabitants into climate and ecology of the region and their practical expertise in thinking out a solution for the unsupportable heat of this region.

3.1 Kat constituting spaces

Kats typically consist of the following spaces:

1. Access space or stairway

2. Adjacent platform to the river or veranda

3. Cavernous rooms or spaces

4. Storeroom

5. Pool

6. Barbecue

7. Air vent or the vertical shaft on top of the place

3.2 Kat features

3.2.1 The existing architectural elements in Kats

***1. Natural ventilation system*:** due to the significant temperature difference between the water and the surrounding environment, the air current and the wind over the river surface moves in direction of the river sidewalls in which Kats are carved and carry the hot air inside the Kat up through the ventilation shaft fixed on the roof. As a result of the air circulation, a cold draft is produced within the place. Also the low-height and thickness of the Kat ceiling contribute to this cooling process. In addition, the cold of the river water induces a sense of coolness in us. Thus, the contributing factors to the air cooling of the Kat space are:

A. Cold water of the river;

B. The shadows created by the river sidewalls;

C. The Kat roof which is at least 2 meter thick and in some places its thickness measures up to 6 meter;

D. The darkness and the shadow which draws the Kat space off the very shiny outside environment; and

E. The Ventilation system provided by a cylinder located above the Kat space.

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***2. Use of arch shape in creating Kat spaces*:** to prevent collapse of the spaces built in the Kat, it is made use of an arch shape.

***3. Privacy*:** the riverine are not at the same level in height and vary from 3 to 15 meter in some places. Standing on top of the cliffs, one could see the river water stream, the cliffs, and the plains on the other side of the river. But for a possible downfall of the cliff edge, no one risks standing thereon. Hence, one cannot catch view of the adjacent platform and veranda, and the built spaces located at lower levels which provides a kind of natural privacy.

***4. Introversity*:** in the Iranian architectural culture, the true value is attached to the substance and the inner core, and the outer crust is merely a figurative coverage which serves protection of truth. It is the inner capped space that determines the genuine essence of the structure to which the exterior features are not comparable. "Throughout the traditional architecture, forms have conveyed and served something above the mere technical contrivances. Apart from their architectural functions which provide a material order, they, more importantly, using symbolic elements, want to remind us the underlying spiritual and moral principles, the principles a traditional building, garden, or view reveals at the level of its reality are at the same time in agreement with inner states of human. In the traditional architecture, like all the traditional arts, nothing is ever detached from meaning and the meaning is nothing but spirituality. Hence, introversive architecture seeks for protection of the environment in which it is born (Ardalan and Bakhtiar, 2001: 9).

***5. Curiosity*:** as we arrive at the place and feel the rough stony cliffs, the insupportable heat, and the sharp rays of the sun, we might say to ourselves, "what a harsh and unbearable condition it is here!" But, as we descend the fairly long stairways, our sense of curiosity starts to grow, making us develop mental images on after another in anticipation of what the things we are about to see.

***6. Dynamism*:** the swift current of the river and the light wind which hangs around are the main sources of the dynamism.

***7. Tranquility*:** the Kat is particularly characterized by the sense of tranquility and serenity it induces in the visitors.

***8. Platform*:** platform which has the most use is positioned between the roofed space and the river.

***9. The stair*:** it is usually made use of irregular, multi-way and spiral stairs.

10. Hierarchy: it primarily concerns application of hierarchy to urban and architectural spaces by distinction between public and private domains where access prioritization (ranking) has played a significant role in enhancement of privacy in spatial structures, to the degree that privacy might be regarded as one of the essential skeletal manifestations of compliance with the principles of hierarchy in edifices and cities of the Islamic period. Establishment of such sustainable values as security, comfort, peace, and privacy that we witness in the traditional structures is owing to application of these principles (Memarian, 2004: 9).

***11. Penumbra*:** the gateways are transparent, semitransparent (translucent), and opaque which by producing a harmony help understanding of the space.

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***12. Contrast*:** the contrast is provided between (I) Intense sunlight of the outside and dark shadow inside of the Kat; (II) Hot weather of the region and cold water of the river; and (III) Excitement and effervescence of the life above and tranquility and inactivity of the Kat beneath.

***13. Privacy*:** privacy as a rule governing all facades of life has been beautifully embodied in the Iran‟s traditional architecture, leaving deep impressions on the spatial organization and arrangement of different functions in spaces (Seifian and Mahmoudi, 2007).

Privacy has been one of the most important principles in the Iranian traditional architecture which especially after introduction of Islam received much attention and was excellently applied to all structures, from massive buildings to housing, and from urban public areas to semipublic and private spaces. Understanding of a principle is understanding of the thing which makes sense of the entire art and civilization of a human society with a shared culture, custom, and belief (Memarian, 2005: 8). A skeleton supported by meditation and prayer, on its way to reunite with its roots and to find the true and genuine assurance and inner peace, finds a harmonic and superb order (Memarian, 2005: 9).

***14. The link between architecture and nature*:** in the connection between Iran‟s traditional architecture and nature, compliance with the privacy rule is crucial. The formation process of structures, which involves a combination with nature and use of its elements, these structures tend to absorb the natural environment and engulf it in its veil (Memarian, 2005: 9).

Draskaya, the Russian orientalist, interprets the word “Kat” as “Carving”. Kat walls are 2 to 4 meter thick the ceiling of which is adorned by naturally formed small and large stones. It is not known for sure at what time these spaces were initially carved and who the creators of them were. But, these spaces evidently have been long used as a shelter for the people who escaped the severe summer heat which at times reached 50˚C . On the other hand, these spaces have been very popular recreational spots where the local people could swim in the adjacent river and have a good time and use the rooms and vacant spaces in the rocks. Even today, a lot of people from the city and other neighboring cities come to these places and spend some time in Kats and near the water.

It is noteworthy that in the past certain group of people who were called *Miraab* (water manager) were in charge of controlling the water inflow to the water supply channels and the underground (subterranean) irrigation network of the time in Dezful and used Kats to stay near the water inlet into the subterranean water network called *Qanat* (aqueduct) in the local language.

Thus, the Kat, at a point in time, had an applied spatial role by accommodating the water system operators, and at another time it provided refuge for the sun strike, and yet in another time during the Imposed War it served as a safe place and citadel. Presently, these spaces are regarded as an ideal place for leisure time (recreation, repose, and relaxation).

The Kat spaces traditionally were to the size of a hole, very simple and in an organic form. But today, the families that economically are doing well own a Kat on the riverside and for a more comfortable stay, they have outfitted their Kat with stairs, storeroom, barbecue, veranda, air ventilation, and WC.

State organizations such as the Islamic Azad

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University, Telecommunication, and Governor"s Office build well-equipped Kats give them to their employees. Thus, the Kat which was considered as an important part of the Dezful traditional architecture today is integrated into and harmonized with the life of a group of the local population.

3.2.2 Access routes to the Kat

A Kat can be reached via two routes:

1. From above the adjacent cliffs to the Kat, stairs are fixed on the Kat front platform
2. Downward from above the cliffs (toward depth of the Kat surface area), a series of stairs are placed. Using this type of stair, Kat private area is defined and formed, so as it is not positioned on a vantage point relative to other Kat spaces.

Conclusion

Mankind, in all circumstances, for his own needs and comfort, acts very flexibly in adapting himself with his environment. Profiting from the available resources and factors in his surrounding nature he always manages to find a suitable solution. For example, due to the intense sun radiation during 8 months of the year and in order to prevent receiving any harm from the heat of the region, he uses materials such as baked clay and bricks, or by means of such spaces as Sabat he manages to cast shade over the lanes. And the Kat is yet another invention of the kind. The native people, profiting from the existing factors alongside the Dez River and the natural cliffs on the riverside, succeeded in realizing their objectives, i.e. comfort and relief in this refuge and resort, without causing adverse consequences for the adjacent natural environment. That is to say, by enjoying cool weather against the heat, and by taking shelter in the shadow and darkness of these natural cliffs against the intense sun radiation through modification and rearrangement of the existing coastal cliffs (the Kat), they made their wishes come true.

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Development of an Efficient in Vitro Micropropagation Protocol for Medicinally Important Plant *Stevia rebaudiana* Bertoni

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Abstract

The current situation of medicinal plants and increasing demand of plant derived drugs suggest an immediate need to conserve our medicinal plant resources. Stevia rebaudiana is a valuable medicinal plant species and it is being used for the treatment of diabetes. Currently, there is a high demand for raw material of this medicinal herb due to ever increasing diabetes disorder among the population. It is becoming an endangered species due to its infertile and small sized seed. The methods of vegetative propagation are not efficient to save this rare plant. In order to meet the increased demand an efficient in vitro propagation of stevia rebaudiana was established. The present study attempted to develop in vitro micropropagation protocol for the important medicinal plant Stevia rebaudiana Bertoni. Shoot tip and node segment of healthy plants from natural condition were used as explants for direct organogenesis. Different concentrations of cytokinin and auxin both alone were used. The results showed that shoot tip explants was far better than node explants. The highest percent of shoot induction (97.78 %) and shoot length (14.3 cm) shoot were obtained in full strength MS media and ½strength MS media from shoot tip explants. The maximum of shoot length (14.6 cm), number of leaf (24 Leaves per explants cultured) and multiple shooting rates (14.4 shoots per explants cultured) were obtained in MS medium fortified with 1.0 mg/l BAP from shoot tip explants. Highest number of root (6.4 roots per shoot cultured) and root length (5.2 cm) were observed in ½strength MS media fortified with 0.5 mg/l IBA. In this study physiological effects of different strengths of Murashige and Skoog (MS) medium and growth regulators cytokinin (BAP, KIN and TDZ) and auxin (IBA) on invitro Proliferation of stevia were investigated. Rooting was best achieved on half strength MS medium augmented with 0.5 mg/l

IBA. The plantlets regenerated in vitro with well-developed shoot and roots were successfully established in pots containing garden soil and grown in a greenhouse with above survival rate. The methods of vegetative propagation are not efficient to save this rare plant. Therefore protocols developed in present investigation are not only useful for its large scale propagation but also conservation of germplasm.

Keywords: Medicinal plant, Micropropagation, Stevia, Tissue culture

Abbreviations

BAP	6-Benzylaminopurine
IBA	Indole-3-butyric acid
KIN	Kinetin
MS	Murashige and Skoog medium
TDZ	Thidiazuron

Introduction

Medicinal plants are the richest source of drugs for traditional medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates etc [15].
Tissue culture techniques can be applied for germplasm conservation, mass propagation and disease free plant production of medicinal plants. Also, it is possible to produce a huge number of plantlets from single explants within shortest span of time [5].
Stevia rebaudiana is one of the important medicinal plant species of Asteraceae family. It is a perennial herb, native to the high- lands of Paraguay [1]. Stevia is one of the 154 members of the genus stevia. It is a sweet herb of Paraguay, which contains natural non-caloric sweetener. It is of immense value due to its adaptability to wide climatic range, the high sweet content, and its significant contribution to the welfare of human life [6]. This plant is indigenous to the Rio Monday Valley of the Amambay Moutain Region where it grows as a perennial at an altitude between 200-500 meters having a mean temperature of 23 °C and rainfall ranging from 1500-1800 mm per annum [9].
The native Guarani tribe had known for centuries the unique sweetening power of its leaves and other medicinal properties. They called the plant "kaa he-he" which translates as "sweet herb" and used it as sweetener for their green herbal tea "mate" and other domestic purposes as a flavor enhancer. In due course, it was introduced to settler [11]. By now, Stevia is being consumed in Japan, Brazil,

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USA, Argentina, China, Canada, Paraguay and Indonesia. Stevia is the new emerging alternative source of calorie free sweetener having no carbohydrate and fat. It is 200 to 300 times sweet than cane and beet sugar, highly nutritious, delicious, non-toxic and non-additive sugar [2]. It also enhances the flavour, helpful in digestion, weight reduction, prevents dental caries and having antimicrobial and anti-plaque properties, increases mental alertness, increase energy levels but does not affect the blood sugar level, therefore key-source sweetener for diabetic world [12]. Besides, Stevia can be used in hypertension, hypoglycemic, helpful in skin toning and healing, tobacco and alcohol cravings and a tonic for pancreas. It can also be used as alternative source of sugar for food confectioneries, bakeries, fruit juices, jams, biscuits, chocolatesl, vegetables and other food stuffs [5].

Seed germination is notably very poor, commonly due to infertile seed. Some plant varieties/selections produce virtually no viable seed due to their self-incompatibility [16]. Under cultivation, Stevia can be propagated by seed, by tissue culture and by vegetative cutting. Since germination rates are poor and seedlings are very slow to establish, it is best grown as an annual or perennial transplanted crop [4]. Clonal propagation is practical for small scale production, but is probably not economically viable for large scale Stevia production in those regions where labour costs are high [13].

Stevia extracts, besides having therapeutic properties, contain a high level of sweetening compounds, known as steviol glycosides, which are thought to possess antioxidant, antimicrobial and antifungal activity. Stevioside and rebaudioside A are the main sweetening compounds of interest [6]. They are thermos table even at temperatures of up to 200C, making them suitable for use in cooked foods. S. rebaudiana has a great potential as a new agricultural crop since consumer demand for herbal foods is increasing and proximate analysis has shown that Stevia also contains folic acid, vitamin C and all of the indispensable amino acids [3]. Stevia cultivation and production would further help those who have to restrict carbohydrate intake in their diet; to enjoy the sweet taste with minimal calories. These over's a solution for complex diabetic problems and obesity in humans, being calorie free. The worldwide demand for high potency sweeteners, particularly natural sweeteners, is expected to increase in the years to come [12].

The cultivation of stevia on commercial basis is done by seed, stem cutting or division of mother plants in green house during winter [5]. The poor seed germination rate and lower success of vegetative propagation by stem cuttings coupled with requirement of enough stocks of stem cuttings and higher labor inputs are the major limit factors in its large scale cultivation [8]. A suitable alternative method to obtain sufficient number of plants within short time duration is the use of in vitro cultures [7]. Further, organ differentiation in plants is regulated by interplay of auxins and cytokinins. A higher cytokinin to auxin ratio promotes shoot formation and the synergistic effect of cytokinin and auxin ratio in the medium enhances the rate of multiplication [2]. The micropropagation of plants through axillary bud culture allows recovery of genetically stable, elite true-to-type progeny. Stevia can form multiple shoots from nodal explants, which are convenient type of culture for multiplication on large scale [15]. In this direction, an attempt has been made in the present study to develop a simple and economical regeneration protocol for rapid rate in vitro micropropagation and finally, acclimatization of the in vitro plantlets to soil conditions.

Materials and methods

Plant material

Stevia rebaudiana Bertoni plants were procured from Agriculture Biotechnology Research Institute of Iran. In this experiment, shoot tip and node segments were used as explants.

Explants sterilization

Young and green shoots of stevia were harvested and washed with running tap water. After shoot tips and node segments were cut into smaller segments (1-2 cm) and used as the explants. The shoot tip and node explants were washed in tap water and gently rinsed with 20% (v/v) extra and surface sterilized in 0.1% sodium hypochlorite solution for 10 min and then rinsed with five changes of sterile distilled water.

Culture media and growth conditions

The culture medium consisted of MS [10] salts, vitamins, 3% (w/v) sucrose and the pH of the media was adjusted to 5.6 with 0.1 N NaOH or HCl before adding of 0.8% (w/v) agar and autoclaved at 121 ◦C for 15 min. The cultures were incubated at 24±2 ◦C under 16/8 h (light/dark cycle) photoperiod (60 μE m^{-2} s^{-1}) and irradiance provided by cool-white fluorescent tubes.

Experiment I

In the first experiment, the effect of MS media types (MS, 1/2MS, 1/4MS, 1/8MS, 1/16MS and 1/32MS) with two explants (Shoot tip and Node) were examined on in vitro micropropagation of stevia.

Experiment II

In this experiment, the effect of different concentrations of three cytokinins was examined on in vitro micropropagation of stevia. shoot tip and node explants derived in vitro regenerated shoot buds as explants source were cultured on MS medium fortified with different concentrations (0.0, 0.5,

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1.5 and 2.0 mg/l) of BAP, KIN and TDZ individually for multiple shoot bud development.

Experiment III

In this experiment were studied rooting of elongated shoots and acclimatization. The elongated shoots (>5.0 cm height) were transferred onto full-strength MS medium and half-strength MS medium fortified with different concentrations of IBA (0.0, 0.5, 1.0, 1.5 and 2.0 mg/l) for root induction. Plantlets with well developed roots were removed from the culture tubes and gently washed under running tap water to remove adhering medium. Subsequently, they were transferred to plastic cups containing sterile sand and soil mixture in 1:1 ratio. The potted plantlets were initially maintained in the controlled environment for two weeks and subsequently they were shifted to the greenhouse. After twenty days, the plantlets were successfully established in the field.

Statistical analysis

Experiments were done in factorial based on completely randomized design (CRD) with 3 replications and observations were recorded after the 4 weeks. The analysis of variance (ANOVA) was performed using SAS program. The differences among means were determined by Dunkan Test at 1% significant level.

Results and Discussion

Effect of different concentrations of MS medium on in vitro micropropagation of *Stevia rebaudiana*

The statistical analysis of variation for percent shoot induction and shoot length showed significant difference for medium types and explant types. Interactive source variation of Medium × Explant showed significance at $p<0.01$ for percent shoot induction and shoot length in vitro condition. Among the 5 different media tested, MS media and 1/2MS media were found to be the best mediums for in vitro micropropagation of stevia. The highest percent shoot induction (97.7 %) and shoot length (14.3 cm) were obtained in full strength MS media and 1/2strength MS media from shoot tip explants (Fig. 1, 2).

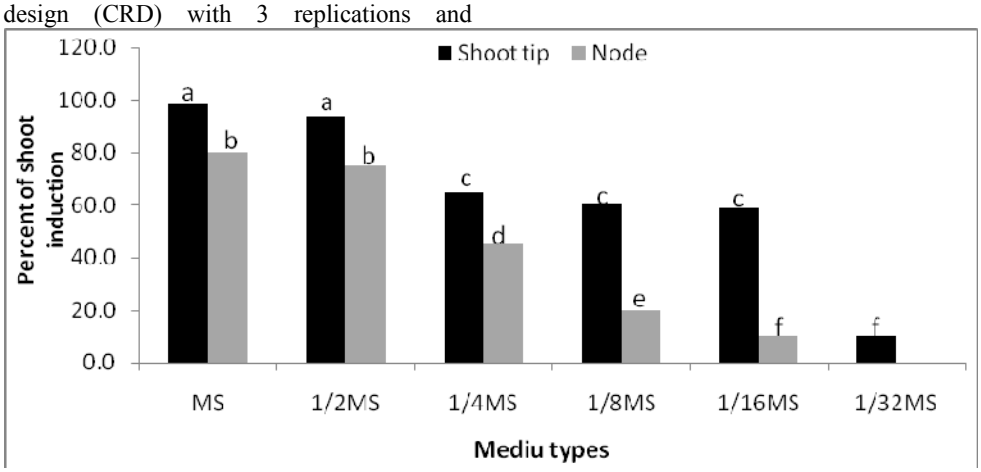

Fig. 1. Effect of different concentrations of MS medium on percent of shoot induction on in vitro micropagation of *Stevia rebaudiana*.

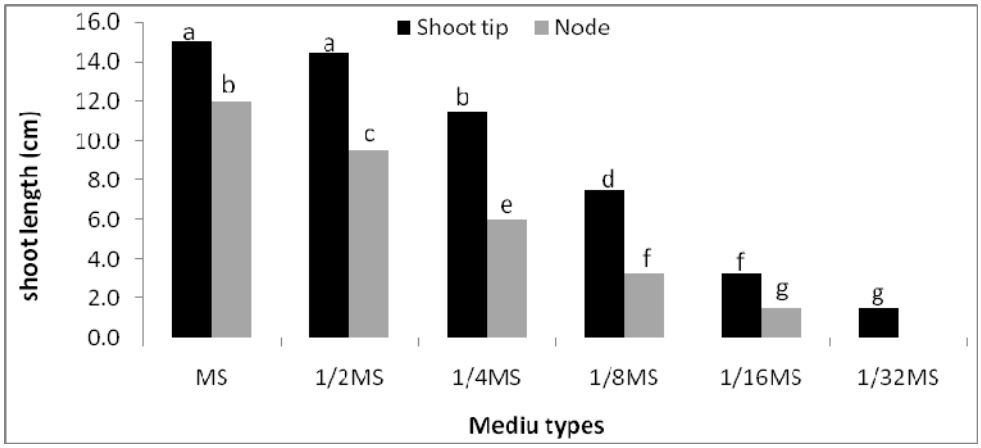

Fig. 2. Effect of different concentrations of MS medium on shoot length on in vitro micropropagation of *Stevia rebaudiana*.

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In vitro propagation of stevia has been shown to have optimum overall growth in MS medium [1, 8]. This experiment were showed that the in vitro propagation of stevia not require high concentrations of MS salts medium.

Effect of different concentration of cytokinins on in vitro micropropagation of *Stevia rebaudiana*

In order to rapid in vitro proliferation of stevia were investigated effects growth regulators cytokinin (BAP, KIN and TDZ). Interactive source variation of Cytokinins concentration × Explant showed significance at $p<0.01$ for shoot length, number of leaf and multiple shooting rate in vitro condition. The multiplication rate was higher in cultures supplemented with plant growth regulators. Also, the percentage of response varied with the type of growth regulator used and its concentration.

Among the various cytokinins tested, BAP was found to be more efficient than others with respect to initiation and subsequent proliferation of shoots. Also, among the concentrations tested, BAP at 1.0 mg/l was found to be the best concentration for highest shoot length (14.6 cm) from shoot tip explant. Also shoot length were declined when the BAP concentration was increased beyond 1.0 mg/l in the medium (Fig. 3). The maximum number of leaf (24 Leaves per explants) was obtained in MS medium fortified with 1.0 mg/l BAP from shoot tip explants (Fig. 4).

Development of multiple shoot is a one of the main target of in vitro micro propagation of stevia. The highest multiple shooting rates (14.4 shoots per explants cultured) were obtained in MS medium fortified with 1.0 mg/l BAP from shoot tip explants (Fig. 5). Also in this experiment was found that the shoot tip explants showed better response in in vitro micropropagation of stevia rebaudiana.

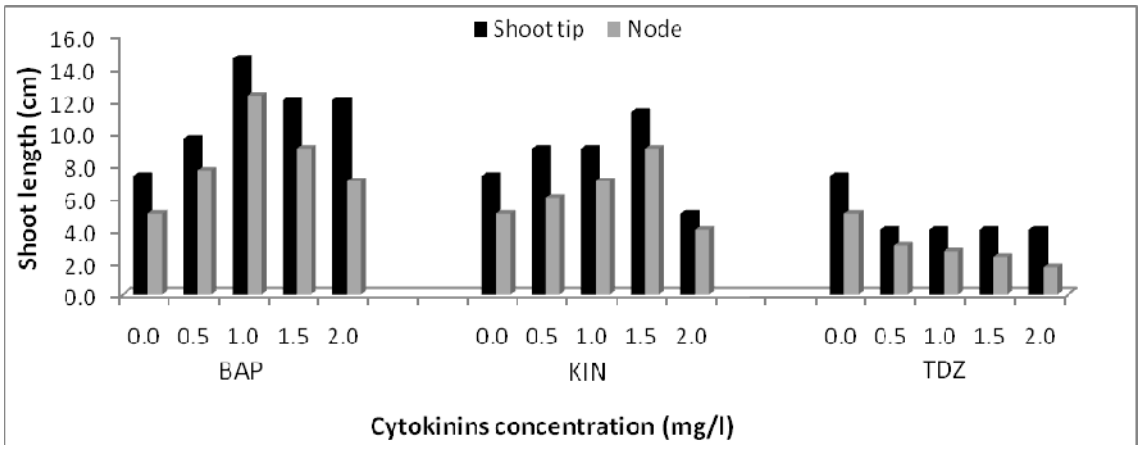

Fig. 3. Effect of different concentrations of BAP, KIN and TDZ on shoot length in vitro micropropagation of *Stevia rebaudiana.*

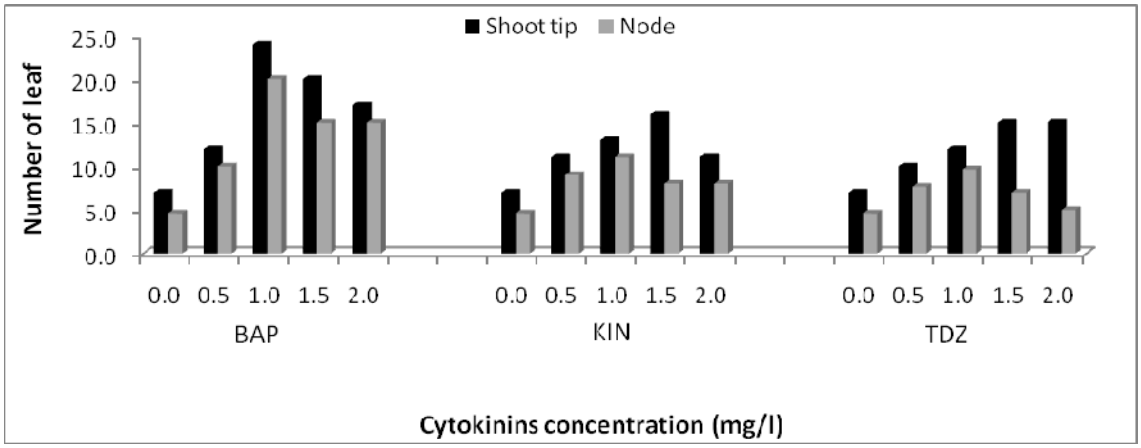

Fig. 4. Effect of different concentrations of BAP, KIN and TDZ on number of leaf in vitro micropropagation of *Stevia rebaudiana*.

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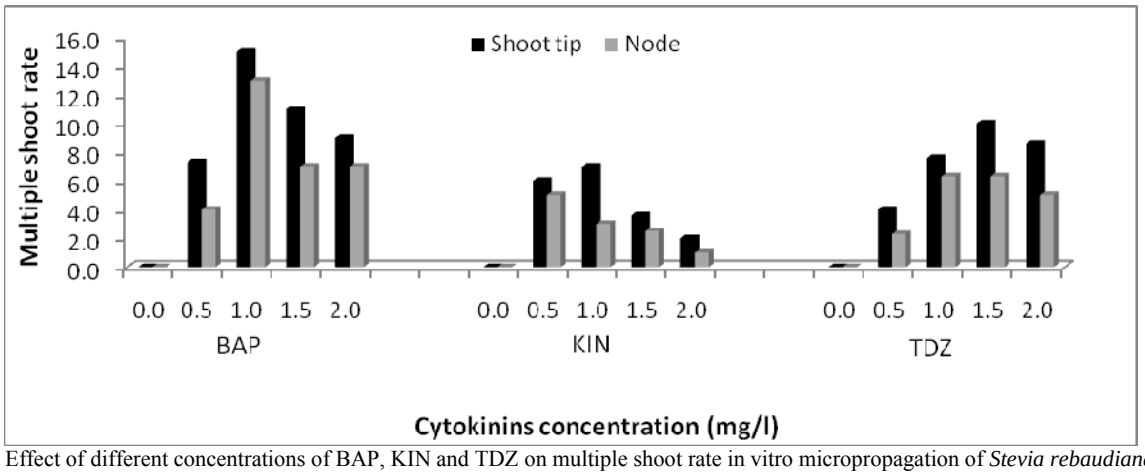

Fig. 5. Effect of different concentrations of BAP, KIN and TDZ on multiple shoot rate in vitro micropropagation of *Stevia rebaudiana.*

The effect of BAP on multiple shoot formation has been studied in various medicinal plant species [15]. The highest shoots multiple shoots Induction were reported in MS medium supplemented with 1 mg/l of BAP [13]. Also has been reported maximum number of shoots was produced in MS medium supplemented with 0.6 mg l-1 of BA [14].

Rooting of elongated shoots of Stevia rebaudiana

For rooting, elongated shoots were transferred to full MS medium and half strength MS medium supplemented with different concentrations of IBA (0.0, 0.5, 1.0, 1.5 and 2.0 mg/l). Shoots produced roots within two weeks of culture and the data were recorded. Interactive source variation of IBA × Culture medium showed significance at $p<0.01$ for number of root and root length of in vitro produced plantlets. Highest number of root (6.4 roots per shoot cultured) and root length (5.2 cm) were observed in ½strength MS media fortified with 0.5 mg/l IBA. The number of root and root length were increased with increasing the concentration up to 0.5 mg/l while the rooting was declined beyond 0.5 mg/l IBA used in the half-strength MS medium (Fig. 6 , 7).

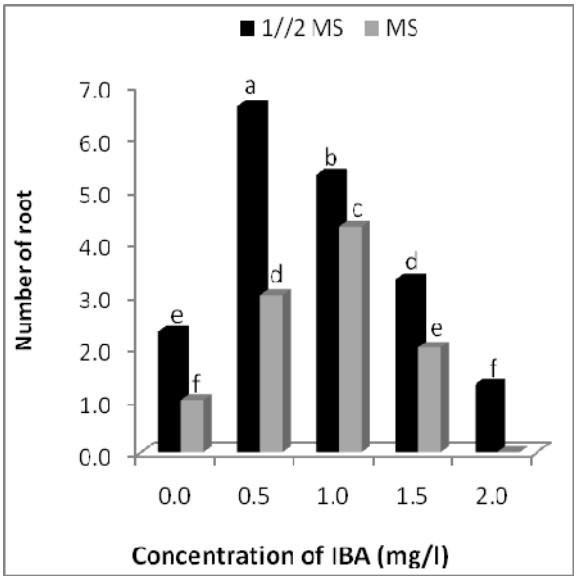

Fig. 6. Effect of different concentration of IBA and MS medium strength on number of root on in vitro micropropagation of *Stevia rebaudiana*

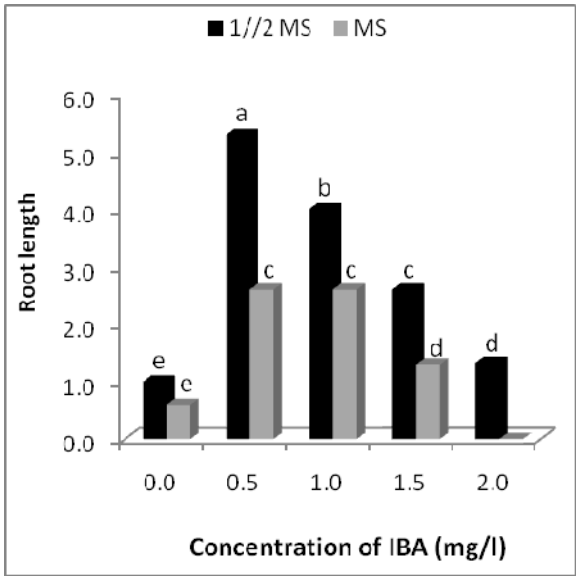

Fig. 7. Effect of different concentration of IBA and culture medium on root length on in vitro micropropagation of *Stevia rebaudiana*

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Acclimatization

The rooted plantlets with expanded leaves were transferred successfully into plastic cups containing sand and soil in the ratio of 1:1 and covered with polythene bags to ensure high humidity. The plantlets were kept in the controlled environment for two weeks and the polybags were gradually removed in order to acclimatize the plantlets under greenhouse conditions. Subsequently they were transferred to the field conditions.

Conclusion

This report describes a rapid protocol for in vitro micropropagation of Stevia rebaudiana from shoot tip and nodal explants. This study provides an efficient in vitro propagation method that could be commercially feasible for stevia using a simple protocol for producing uniform plants in a relatively short period and with high multiplication rate. This protocol can be utilized for commercial scale propagation and conservation of this important medicinal plant species.

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The Effect of Eight-Week Walking Exercise on General Health and Cardiovascular Risk Factors among Employees of Education Department in Bastak County

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***Abstract*—**This research aims at determining the effect of eight weeks of walking exercise on general health and some cardiovascular risk factors among employees of Education Department in Bastak County. A semi-empirical methodology was adopted. The statistical population contained 50 non-athlete employees of Education Department in Bastak County who voluntarily participated in the study. They were randomly dividend into two groups of control and empirical. The exercise was done for eight weeks, each week including 3 sessions of 1 hour walking with the intensity of 65 to 75 percent of maximum heart rate. After the walking sessions, data analysis by the use of T-test showed a significant reduction in the levels of depression, stress and sleep disorder, triglyceride, cholesterol, lipoprotein with low density in subjects; however they showed a significant increase in general health, physical health, social performance and lipoprotein with high density in subjects ($p<0.05$). Research results showed that walking increases the general health and reduces cardiovascular risk factors among employees. Therefore, walking has a positive effect on general health and prevents people from cardiovascular diseases.

***Keywords*—**walking, general health, cardiovascular risk factors, employees of Educational Department of Bastak County

I. Introduction

Cardiovascular diseases have increased in recent decades. Today they are known as one of the main causes of death in the world. About half of all deaths in industrial countries and 25 percent of deaths in developing countries are related to coronary heart disease [1]. Walking is one of the most common leisure activities associated with risk reduction of chronic diseases such as obesity, high blood pressure, cardiovascular diseases and different types of diabetes [2]. Positive effects of walking on different aspects of health have been proven [3]. Evidence indicates that exercise can improve body composition and treat musculoskeletal disorders following heart attacks as well as acute respiratory disease [4]- [5]. It is also effective in improving independence and social well-being [6]-[7]. Various studies have shown the effect of daily multiple short-distance sessions of walking and one session walking on reduction of risk factors in coronary heart diseases (CHD) [8] as well as the reduction of mental stress and depression [7]. Various national and international studies have shown the positive effects of walking on physical and mental health and increasing confidence [9]-[11]. With regard to the importance of walking on general health and other cardiovascular risk factors, the current study aims at

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investigating the effect of eight-week walking exercise on the level of general health and other cardiovascular risk factors among employees of Education Department in Bastak County.

II. Materials and methodology

This is a semi-empirical and practical research conducted on two groups of control and empirical. The statistical population includes 50 employees of Education Department in Bastak County with no sport background and complete physical health. The exercise was done for eight weeks, each week including 3 sessions of 1 hour walking with the intensity of 65 to 75 percent of maximum heart rate. The measuring tool used in this study was the General Health Questionnaire (GHQ) which included 28 questions measuring subscales (physical health, stress and sleep disorder, social performance and depression). In order to determine the level of cardiovascular risk factors, venous blood samples were obtained from subjects in a pre-test and a post-test after 12 hours of fasting. Enzymatic (Colorimetric) method and kits from biochemistry companies were used to measure the density of HDL, LDL, TG and TC. Descriptive statistics were used for personal characteristics of subjects and inferential statistics were used to compare the means of t-test subjects in pre-test and post-test. The statistical software, SPSS version 16 was used to analyze the data.

III. Findings

Table (1) shows the measured factors before and after the eight-week walking exercise. Findings indicate a significant difference between general health, physical health, stress, social performance, depression, blood cholesterol, triglyceride, lipoprotein with low density and lipoprotein with high density before and after the eight-week walking exercise among employees of Education Department in Bastak County.

Table (1): comparison of general health factor and other cardiovascular risk factors among subjects in pre-test and post-test

t-test	mean		t-value
↓ variable	before exercises	after exercises	
general health	19/18	10/38	14/45
physical health	5/32	2/64	8/73
anxiety	4/22	2/28	7/45
social performance disorder	5/08	2/58	8/78
depression	4/56	2/68	7/82
TG	117/68	98/98	11/33
TC	153/70	153/34	2/48
LDL-C	136/66	119/94	4/37
HDL-C	52/03	58/27	3/57

IV. Discussion and conclusion

The results of the current research generally showed that doing an eight-week walking exercise among employees of Education Department in Bastak County can have various effects on general health and other cardiovascular risk factors. The result obtained from data analysis showed that the level of general health, physical health, social performance and lipoprotein with high density of subjects increased significantly ($p<0.05$) after morning exercise. Some of the researchers found out that exercise intensity can be effective in increasing the level of HDL, such that its level after high-intensity workouts can significantly increase compared to low-intensity workouts [12]. On the other hand, weight, sex, protocol of subjects and their duration of workout appear to be an important factor in response to various exercises. HDL with reverse cholesterol transport can lead to the reduction of cardiovascular diseases [13]. The current research results showed that the level of depression, stress and sleep disorder, LDL, TG and TC have decreased significantly ($p<0.05$). Hiroko Sugiura et al. (2002) stated that exercising increases the activity of lipoprotein lipase (LPL) enzyme and lecithin cholesterol acyltransferase (LCAT) which in turn reduce LDL, triglyceride and cholesterol and increase HDL [14]. Wilund et al. (2009) confirmed that by increasing cholesterol absorption characteristics, aerobic exercises can decrease LDL and consequently prevent heart diseases [15]. Peiravi (1383) in a study stated that morning exercise is effective in reducing mental pressure and promoting peace [16]. Rajoey (2010) concluded that exercising in the morning compared to other times is more beneficial for the performance of various body systems due to morning fresh air. Also inhaling morning fresh air can increase mental alertness level in human beings which in turn leads to more peace and the reduction of stress [17]. Aerobics exercises are physically beneficial for people, including: increasing cardiac output, reducing the maximum oxygen consumed, reducing blood triglyceride, reducing obesity and

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controlling body weight, reducing heart beat and blood pressure. Freshness and happiness, reducing stress tension, feeling peace and comfortable sleep, reducing anxiety and boredom and improving mood are mental effects of aerobics on people. Meanwhile, morning exercise is more effective because it is done in the fresh and clean air of morning and before daily activities have begun.

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The Effect of Eight-Week Walking on Cholesterol, Triglyceride, LDL, and HDL Levels in Bastak County Education Department Employees

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***Abstract*–**This study determines the effect of eight-week walking on Bastak County Education Department employees' cholesterol, triglyceride, LDL, and HDL levels. It was a quasi-experimental research. The study sample consisted of 50 non-athlete employees of Bastak County Education Department. They voluntarily participated in this study. The participants were randomly divided into test and control groups. Participants were involved in an eight-week walking procedure (three 1h sessions in a week at maximum heart rate between %65 and %75). Data was analyzed using correlated t-test. After the end of walking procedure, significant decrease was observed in triglyceride, cholesterol, and Low Density Lipoprotein (LDL) levels. Yet, significant increase was seen in High Density Lipoprotein (HDL) level ($p<0.05$). Results indicated that walking for eight weeks can have positive effects on some cardiovascular risk factors.

***Keywords*–**walking, Cholesterol, Triglyceride, LDL, HDL

I.Introduction

Cardiovascular diseases have increasingly grown in recent decades. Today, the disease is known as one of the main mortality factors across the world; almost %50 in industrial countries and %25 in developing countries [1]. Based on recent studies, cardiovascular risk factors are at undesirable level in Iran [2]. Walking is one of the most conventional leisure activities related to the reduction of some chronic diseases such as obesity, high blood pressure, cardiovascular diseases and different types of diabetes [3]. It is also one of the economic and feasible physical activities with no need to have specific timing and special skills [4]. Walking is proved to have positive effects on the different aspects of health [5]. Evidences indicate that exercises can improve body composition and musculoskeletal disorders after heart attack and acute respiratory diseases [6]-[7]. Various studies have shown the relationship between short term multisession-a-week and once-a-week walking on the reduction of Coronary Heart Diseases (CHD) [8] as well as stress and depression [9]. Regarding the significant effect of walking on some cardiovascular risk factors, this study determines the effect of eight-week walking on Bastak County Education Department employees' cholesterol, triglyceride, LDL, and HDL levels.

II.Materials and Methods

It was a quasi-experimental applied research done by test and control groups. The study sample consisted of 50 Bastak County Education Department employees with no background of sport activity. All participants were completely healthy. Participants were involved in an eight-week walking procedure (three 1h sessions in a week at maximum heart rate between %65 and %75). To determine TG, TC, HDL, and LDL levels, participants' venous blood samples were provided after 12h fasting using pretest and posttest. HDL, LDL, TG, and TC densities were measured by

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enzymatic (calorimetric) method using Biochemistry Company kits. Data was analyzed by means of SPSS16.

III.Results

Table (1) shows factors measured before and after walking for eight weeks. Results indicate significant differences between cholesterol, TG, LDL, and HDL before and after the walking procedure between Bastak County Education Department employees.

Table (1): Pretest results versus posttest results regarding some cardiovascular risk factors

t-test	mean		t-value
variable ↓	before exercises	after exercises	
TG	117/68	98/98	11/33
TC	153/70	153/34	2/48
LDL-C	136/66	119/94	4/37
HDL-C	52/03	58/27	3/57

IV.Discussion and Conclusion

Generally, results of the present study showed that administering eight-week walking procedure on Bastak County Education Department employees can have different effects on some cardiovascular factors. Based on HDL levels, these findings correlate with the results reported by Arthurs (2001) and Park (2003) [10]-[11]. Yet, they oppose the results reported by Manish (2006) and Elliott (2002) [12]-[13]. Some researchers have concluded that training intensity can affect the increase of HDL levels. That is, HDL levels can have significant increase after high intensity training versus low intensity training [14]. On the other hand, participants' weight, gender, protocol, and training term seem to be important factors in how they respond different sport exercises. By the reverse transfer of cholesterol, HDL decreases the outbreak of cardiovascular diseases [15]. Again, results of this study showed that LDL, TG, and TC levels have significantly decreased. These results correlate with the results reported by Arthurs (2001), Park (2003), and Taheri (2007) [10],[11],[16]. Yet, they do not correlate with the findings reported by Isfahani (1999), Behpour (1996), Afzalpour (2007), Manish (2006), and Elliott (2002) [12],[13],[17]-[19]. Hiroku Sugiura et al (2002) stated that exercise increases the level of lipoproteinlipase (LPL) and lecithin cholesterol acyltransferase (LCAT). These two enzymes lead to the reduction of LDL, TG, and CT. Yet, they increase HDL [20]. Wilund et al (2009) stated that aerobic exercise can result in the reduction of LDL by enhancing cholesterol absorption properties. As a result, it prevents from cardiac disease [21]. Several studies have shown relationship between aerobic exercise and the reduction of individuals' serum LDL-C and TC levels [22]-[23]. In a study by Weise et al (2005), one session aerobic exercise led to the reduction of participants' total CT levels [24]. Based on the results of different studies, there is correlation between changes in LDL-C and TC levels. Almost in all studies, these changes are the same. Factors which can affect LDL-C levels also influence TC levels. Accordingly, the aforementioned factors affecting TC can also affect LDL-C. Aerobic exercises have many positive physical effects. Among them, followings can be implied: enhancing heart efficiency and output, reducing maximum oxygen intake, reducing blood TG, decreasing obesity and body weight control, reducing heart beat and blood pressure. Hence, it can be said that walking can have desirable effect on cardiovascular diseases indices. It can be considered as an effective factor for preventing from cardiovascular diseases.

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