

Non-destructive Determination of Moisture Content and Brix Value in Carrot, Using Near InfraRed Spectroscopy (NIRS)

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ABSTRACT

One of the very effective ways to increase the marketability and sales of agricultural products is their proper sorting as according to their morphological characteristics, in addition to their internal quality. Water and soluble solid contents are two of the important quality factors in carrot. Although such other ways as image processing can be made use of to sort an agricultural product, the spectroscopic method can be a more sophisticated way of assessing the internal quality of the product. In this research optical method as based on Near InfraRed Spectroscopy (900-1600 nm) has been employed to determine moisture content and brix index in carrot. A total number of 60 samples were taken for the modeling, whereas 40 samples used for the calibration set. A number of 20 samples were taken to be employed for prediction set. Four pre-processing methods, including average smoothing, Multiplicative Scatter Correction (MSC), first and second derivatives, were applied to improve the predictive capability of the models. Then models were then developed through Partial Least Squares (PLS). The correlation coefficient (R^2) and Root Mean Square Error of Prediction (RMSEP) amounted to 0.92 and 1.13 for moisture content, whereas 0.96 and 1.07 for SSC, respectively. The results indicate that NIR can be recommended as a rapid method to determine soluble solid as well as moisture content in carrot.

Keywords: Carrot, Near Infrared, Brix value, Multiplicative scatters correction.

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Mulberry Qualitative Parameters' Modelling within the Drying Process, Employing Artificial Neural Networks

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ABSTRACT

Mulberry (*Morus alba*) has been figured out as one of the useful fruits with sufficient levels of safe sugar. Considering the many advantages of artificial intelligence technology, the application of this technique has been extensively developed to model the required parameters in fruit drying procedures. In this study, mulberry drying experiments were implemented in a hot air dryer in two initial moisture content levels ($80\pm 1-85\pm 1$), three temperature levels of 50, 60 and 70 °C as well as three air speed levels of 1/5, 2 and 2/5 m/s while in stable conditions of atmospheric moisture. In order to model the quality of drying, (MLP) neural networks of various thresholds and neurons as well as Levenberg-Marquardt algorithm and threshold function of tan-sigmoid were employed to instruct the networks. The results indicated that the most appropriate neural network layout of the structure of (3-12-3) and the threshold function of (Logsig and Purelin) indicate the most recommendable result as compared with the other topologies with the largest coefficient (0/9998) vs. lowest MSE (0/00002).

Keywords: Mulberry, Drying, Modelling, Total dissolved solids, Acidity

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An Investigation on Pistachio Drying in a Solar Dryer Equipped with an Air to Air Waste Heat Recovery System

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ABSTRACT

Only a small percentage of provided thermal energy is used for the drying process in the hot air dryers while, a large fraction is lost via the dryer walls and through the exhaust. Throughout the present study a solar pistachio air dryer was developed, equipped with a simple heat recovery system. The evaluation tests were conducted at different levels of drying temperatures (55, 65 and 75°C) and air flow rates (0.045, 0.065 and 0.085 kg/s). The results revealed that rising the temperature from 55 to 65°C led to a reduction of 57.61% in the drying time, 24.32% in solar fraction, 6.8% in recovery fraction and 2.56% in the collector efficiency. Meanwhile, the average electricity consumption at temperature of 75 °C was 1.9 times that at 55 °C. Increasing the air flow rate from 0.045 to 0.085 kg/s improved collector efficiency and recovery fraction while it led to a reduction of 20.54% in solar fraction. In total, it can be said that the waste heat recovery system accounted for about 28.58% of total energy needed for pistachio drying. The results also indicated that both shell splitting number and pistachio kernel strength increased at the higher air temperatures.

Keywords: Solar Dryer, Waste Heat Recovery System, Energy Fraction

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Isolation and Characterization of Lactic Acid Bacteria in Traditional Dairy Products (*Richal Masti*)**FARZAD KARIMPOUR¹, SEYED HADI RAZAVI^{2*}, FLORA NUBAR TKHRUNI³**

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ABSTRACT

Throughout the present study, some *Richal* consisting of traditional yoghurt, local herbs, plus salt was prepared, and then put in *Mashk*. The sample was prepared within aseptic conditions. After the growth of bacteria on special culture media, the bacteria in the media were isolated and purified. Some such tests as biochemical, antibacterial properties, inoculation variance as well as growth conditions within different media, temperature, and time, were carried out and investigated. A number of thirty colonies were isolated and purified. The strains were all Gram-positive, 28 colonies were distinguished as catalase-negative, 26 as homo fermentative, one colony hetero fermentative, 20 ones aero tolerant and finally 10 ones obligate anaerobic. Through Sherman test, the thermal stabilities of 13 colonies were determined. The strains were all grown on different media broth, Agar and fermented milk. The richest growths occurring on Agar Medias were the ones on Lacto and Milk Agars. The strains acting against food spoilage included *S.typhimurium*, *B. subtilis*, *B. Thuringensis*. They were assessed as carrying antibacterial properties. The bacteria of salmonella demonstrated to be more resistant than the others. Referring to the results it seems this LAB is of the potential to act as a starter culture in food industry. Finally, colonies were inoculated in 60% glycerol and 40% fermented milk or in MRS medium at sterile conditions in micro tubes, and kept in freeze conditions for future studies.

Keyword: Lactic acid bacteria, *Richal Masti*, Traditional dairy products

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Application of VISible and Near-InfraRed Spectroscopy for Identification of Cadmium (Cd), and Lead (Pb) Pollution in Soil, Utilizing Regression Models and ANN

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ABSTRACT

Soil pollution by heavy metals can directly or indirectly affect the health of organisms. With increase in the concentration of metals in the soil, it is likely to get also increased in plants. Because of their accumulation in agricultural products, hazardous events would happen to human health if consumed. The aims followed in this study were to determine the distribution of cadmium and lead in topsoil in Bahar city of Hamadan, and to evaluate the extent of pollution of these metals incurred to agricultural lands on which potato was cultivated. Therefore, systematic sampling was used, soil samples were taken from the depth of 0-45 cm. VISible and Near-InfraRed (VIS-NIR) spectroscopy was provided as a quick and accurate method within 370 -2000 nm range. The reflectance spectrums of 95 soil samples were taken to estimate the concentration of cadmium and lead. To reduce noise on soil spectra, MSC, SNV and derivative preprocessing methods were employed. The results demonstrated that contamination usually occurs due to combining of sewage irrigation water, which causes the accumulation of the metals in the topsoil. Prediction of heavy metals was estimated through Partial Least Squares Regression and Artificial Neural Network ($R^2_{PLSR} = 0/90$, $R^2_{BPNN} = 0/95$). Results finally indicated that BPNN is more convenient for modeling of Cadmium and lead utilizing VIS-NIR in topsoil.

Keywords: Soil heavy metals, Partial least square regression, artificial neural network, VIS-NIR spectroscopy

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The Effect of Some Crop and Soil Parameters on Physical Damage and Mechanical Properties of Potato during and after Harvesting

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ABSTRACT

The effects of three varieties of potato (Sante, Agria and Fontana), three harvest times (mid-September, early to mid-October) and two soil moisture contents (9 and 15%) on physical injuries and some mechanical properties, as due to mechanical harvest and as well due to two months past of storage were investigated. The results indicated that variety, harvest time and soil moisture content significantly affect the damage inflicted upon the crop. From this point of view, Agria, Sante and Fontane varieties have respectively born the most damages. A higher degree of damage was related to soil moisture of close to wilting point (9 percent), and a minimum related to soil moisture of near field capacity (15 percent). As for harvesting time the maximum and minimum losses were respectively obtained for early harvesting (middle of September) and late harvesting (middle of October). Variety, harvest time, soil moisture content at harvest time, and duration of storage, significantly affected the mechanical and physical properties of the crop, potato. The maximum and minimum energy required for rupture of the crop went respectively to Fontane and Agria varieties.

Keywords: Potato, Damage, Mechanical Harvest, Mechanical properties

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Comparison of Feature Points Detection Algorithms in Different Color Spaces to Create 3D Map of Trees

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ABSTRACT

Such within orchard agricultural practices as spraying, irrigation, etc. are highly related to, and dependent upon the canopy of a tree and on the tree's form especially when dealt with its structure in the area of precision agriculture and agricultural robotics. So, here a 3D model and a root map of the tree can be helpful. One method of creating such a 3D model is stereovision. The most important problem in this method is the corresponding points. To correspond, one must first identify the feature points in each image. Different algorithms have been initiated for this purpose. Throughout the present study, 6 algorithms, including Harris-Stephens, Minimum Eigenvalue, MSER, FAST, SURF and BRISK were compared in RGB, G, HSV, H, YCbCr, Y, NTSC, Lab and "a" spaces. The results indicated that that SURF algorithm presented the most appropriate performance. Detected feature points through this algorithm were fixed in most spaces, so this algorithm was found stable in different spaces. Following SURF algorithm, MSER algorithm offered the next best performance. This algorithm detected the tree's final crop as feature points. Although the number of these points is limited, but if they cannot be matched as corner points in any of the two images they can be used to match as common points (key points). Algorithms had the most appropriate performance in the HSV, H, YCbCr and NTSC spaces and acted with more stability in RGB and Y spaces in terms of the number of detected feature points.

Keywords: Tree, Stereo vision, Feature point's detection algorithms, Color spaces, SURF, MSER.

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Stress and Modal Analysis of MF285 Tractor's Crankshaft using Finite Element Method

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ABSTRACT

Agricultural tractors, as a basic source of power for implementation of agricultural mechanization, supply the required power for most of the agricultural operations. Most agricultural operations are heavy, requiring high levels of power. For provision of such a required power, the key parts of a tractor engine are under great loads and stresses which could lead to failure in a relatively short time. Here, the loads acting on the crankshaft of a MF285 tractor engine were evaluated at different rotational speeds using Newtonian formulas. Maximum resultant acting forces of 98936.438 N and 103048.7 N were recorded on the crankshaft at rotational speeds of 1300 rpm and 2200 rpm, respectively. The crankshaft was modeled, making use of Solidworks 2012 Software and by defining boundary conditions and inserting the calculated forces and torques in Abaqus 6.10 .1 software. Dynamical stress and modal analyses were conducted on the crankshaft. The results indicated that filleted areas were under maximum stress and maximum stress of 154.8 Mpa occurred at the rotational speed of 1300 and 2200 rpm. The maximum stress level was below the yield stress and safety factor of 4.52 was obtained for the crankshaft. Modal analysis showed that crankshaft works at safe velocity and it does not reach to critical velocity.

Keywords: Engine, Crankshaft, Stress analysis, Modal analysis, MF285 tractor

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Fuzzy Approach to Optimize the Overhaul Time of Sugarcane Harvester using GERT Network Method

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ABSTRACT

The timing of a major overhaul of a sugarcane harvester, to prevent the unavailability of machinery at the pre-specified time of need, and with the aim of reducing the time loss of doing tasks is studied in this work. The overhaul scheduling of the sugarcane harvester is intended to find the optimal sequence of operations in line with the other implements. This issue is often studied to minimize the time duration of the schedule. Fuzzy GERT Network, using the GERT capabilities in Planning and use of fuzzy logic in the expression of uncertainties, is found as the proper tool for the overhaul scheduling of sugarcane harvester in Amir Kabir Agro-Industry of Khuzestan Province, Iran Data were collected from a variety of such sources as obtaining the opinions and comments of experts as well as reports and statistic figures of Sugarcane Agro-Industry. The project activities were initially determined. GERT network was then plotted and analyzed. The time of completion of overhaul scheduling of sugarcane harvester through the method of fuzzy GERT for the various times of optimistic, probable, vs. pessimistic ones were respectively equal to 685.62, 1097.36, 1513.65 man-hours. The minimum and maximum fuzzy time of the project completion with α -cut (0.5) is estimated as 891.49, 1305.50 man-hours. The results of the review process for real-time of annual overhaul for 23 Amir Kabir Agro-Industry sugarcane harvesters working during 1389 -1394 years, on which overhaul was performed, show that 20.29 percent of the actual time to complete the task, is estimated out of fuzzy time. This method would allow the repair shops' managers to use more accurate planning to reduce the reasons for the delay in operations, reduce timeliness costs and manage the completion time of the different operations in their optimal timeframe.

Keywords: Amir Kabir Agro-Industry, Fuzzy logic, GERT, Scheduling

Development of an Electronic Tongue Based on Glassy Carbon Electrode for Quantification of Ascorbic Acid

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ABSTRACT

Fruit juices are of ample benefits to human health due to their containing of the essential vitamins needed by the body. In the meantime, they are vulnerable to fraud and mischief by being mixed with impurities. The compounds found in foods as ingredients are complex, so it is difficult to determine their exact quantity and qualitative nature values. The use of chemical methods to assess and find out the complex food components is often time-consuming and relatively expensive. Lately the electronic tongue has been widely used in the food industry and in particular it has demonstrated a promising outlook for determining the quality and originality of a product. Throughout the present study, an electronic tongue system based on glassy carbon electrodes and cyclic voltammetry was employed for quantification of ascorbic acid. The results indicated that the proposed electronic tongue is of the capacity to quantify ascorbic acid. Furthermore, the results revealed sound correlation ($y = 0.0622x - 1.1547, R^2 = 0.998$) between ascorbic acid concentration and cathodic peak currents.

Keywords: Fruit juice, electronic tongue, ascorbic acid, cathodic peak, voltamogram.

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Regression Analysis of Some Technical Factors Regarding the Drift and Droplet Sizes at Spraying, by Use of Laboratory Data as well as Software

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ABSTRACT

To evaluate the technical factors affecting drift and droplet size of turbo liner sprayer and its regression analysis while spraying, a research was conducted in canola fields at the Ramin Agriculture and Natural Resources University of Khuzestan in year 1394. A three factorial experiment of three replications in a completely randomized design was performed. The first factor represented the pressure of the sprayer at three levels (10, 25 and 35 bar), the second one being the fan speed at two levels (1998 and 2430 rpm) and the third one forward speed at two levels of 9 and 13.5 km/ hr. With an increase in spraying pressure, fan speed and forward speed, the drift increased and the droplet size as well as sediment decreased at a level of 1% significance. According to the results obtained from linear regression analysis concerning the drift, sediment and droplet size, the pressure is found to affect the drift, DV50 and sediments the greatest.

Keywords: Drift, Droplet size, Spraying, Regression Model

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Feasibility of Acoustic Detection and Testing within a Range of Operating Temperatures, Sawtoothed (*Oryzaephilus surinamensis*) (Col. Silvanidae)

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ABSTRACT

With advanced equipment and development of software in the field of audio signals, it is now possible to record and register the sounds of tiny insects. Subsequently the acoustic features of the insects' sounds can be distinguished, and then used for the detection of the insect within the storehouses of bulk materials. One of the problematic challenges in receiving the audio signals emitted from the tiny insects is their low sound level. The designed audio system utilizes a piezoelectric acoustic sensor for receiving audio signals of the pest rice Sawtoothed (*Oryzaephilus surinamensis*) (Col. Silvanidae) along with a temperature control system. Two audio signals (walking and feeding) of Sawtoothed were captured by the sound system. The audio frequency of Sawtoothed for feeding and walking were 2.1 kHz and 2.8 kHz, respectively. By changing the ambient temperature, it was found that the most appropriate temperature range for the pest activity ranged between 25 °C and 27 °C. It was also observed that the pest activity is stopped at a temperature below 10 °C. Such a system may be installed within the storages of bulk rice for early detection and other management decision makings as regards the rice Sawtoothed control.

Keywords: Sensor, Acoustic, *Oryzaephilus surinamensis*, Temperature

Design, Construction and Evaluation of a Tractor Mounted Garlic Harvester Machine

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ABSTRACT

Harvesting is one of the most tedious and intensive labor demanding stages of garlic production calling for a lot of money and effort. In Iran, except for the tillage operations, other production processes are often non-mechanized and therefore manually done. To partly meet this problem, throughout the present work, a mechanical potato harvesting machine was designed, constructed and evaluated. The machine pulls and cuts the plants out of the ground through two V-shaped belts and a cutting blade, carrying them to the topping unit where the heads are cut. The power required moving the belts and topping unit is taken from the carrier wheels. To evaluate this machine, some tests were carried out while considering two parameters, namely forward advance speed at three levels (3, 4 and 5 km/h), and three linear speeds of belts (1.2, 1.4 and 1.6 times advancement speed) using factorials in a completely randomized form and with different blade angles. The results show that the most practical performance of the machine occurs at a forward speed of 3 km/h. The most appropriate conditions for the highest quality heading were then obtained as a forward speed of 3 km/h and the belts' linear speed of 1.2 times that of the forward speed.

Keywords: Garlic, Harvesting machine, Tractor mounted labor-demanding

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Design, Construction and Evaluation of an Abrasive Blasting System for Cleaning of Pests Appearing on Orange Peel

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ABSTRACT

Annually, Chaff scale (*Aonidiella orientalis*) causes a lot of damage to citrus orchards by reducing the marketability of the products. This research was conducted to design, construct, and evaluate a prototype model of the abrasive blasting system for removal of chaff scale from orange peel surface. In this system, a mix of sand and high-pressure air is thrown on the surface of pest inflicted fruit causing the pests to be removed from the fruit peel. In order to evaluate the device's performance, different levels of air pressure (2, 3.5 and 5 bars) and different average diameters of sand (0.5, 0.75 and 1 mm) were used for removal of the pest from the peel surface of the orange samples. To evaluate the level of pest removal, images of the samples were captured prior and past the abrasive blasting, using a machine vision setup. Finally, the degree of cleaning of pests from the orange peel surface was analyzed in different treatments, using image processing technology. According to the statistical analyses, the system showed the most efficient cleaning performance within 0.75 mm average diameters of the sand and 3.5 bar spraying pressure, with an accuracy of 94.9 percent.

Keywords: Orange, Pest, Sandblast System, Surface Cleaning.

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Developing and Testing of a Cylindrical Dielectric Sensor for Measuring Sugar Concentration in Sugar Beet Syrup

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ABSTRACT

Continuous (on-line) measurement and monitoring of the sugar concentration in sugar beet syrup at different stages of concentrating processes is one of the fundamental steps performed in sugar industry. In this study, a cylindrical dielectric sensor was developed and evaluated for a measurement of the sugar concentration in sugar beet syrup in terms of %Brix. The sensor consists of a cylindrical steel tube and a central core as the capacitor electrodes connected to function as generator and spectrum analyzer through coaxial cable. For the laboratory tests, sugar beet syrup at five different concentrations of sugar (i.e. %Brix of 26.5, 37.9, 48.7, 54.1 and 62) were tested using the sensor where frequency swept between 0 and 150 MHz. Amplitude-frequency spectra at different %Brix were further analyzed. The results showed strong positive correlations between the first ($R^2= 0.99$) and second ($R^2= 0.98$) resonance frequency and %Brix. Calculated dielectric constants decreased with increase in %Brix of the syrup samples. It was concluded that the dielectric sensor is a promising instrument for measuring the %Brix of sugar beet syrup. The development of this sensor for online measurement of sugar concentration in sugar factories is possible and recommended.

Keywords: Cylindrical dielectric sensor, Sugar beet syrup, %Brix, Resonant frequency

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Location Allocation of Recycling Site of Solid Waste in the City of Karaj using GIS Assisted Analytic Hierarchy Process (AHP) and Fuzzy Logic

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ABSTRACT

Solid waste management, in addition to its constructive role on the economic cycle, is considered as one of the most prominent indicators of development in the developing countries too. Recycling is part of one of the most sustainable solutions in solid waste management. Even though recycling carries large environmental and economic benefits, unfortunately, no coherent and integrated work has been done on it in our country. Finding the most appropriate location for waste recycling is very importantly needed for the proper implementation of the operations and success of the project. The aim followed in this study is to provide a framework for decision making techniques through Delphi, Delphi Fuzzy and Analytic Hierarchy Process (AHP) using Geographic Information Systems (GIS), to identify the potential sites for establishing a waste recycling station in Karaj, Iran. Thus, following an identification of criteria using classical Delphi technique, the standard boundaries of each criterion was assessed using fuzzy Delphi technique. This study led to identification of 13 effective criteria in locating the recycling station and also determining the allowable boundaries. Seven areas were identified as prone recycling stations using GIS and AHP. Finally, three of the seven regions possessing the highest scores were selected as the optimal locations of recycling stations.

Keywords: Location, Recycling, GIS, Fuzzy, AHP

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Design and Implementation of an Electro-Hydraulic Draft Regulating System for MF285 Tractors Using an Adapted Hitch Control Valve

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ABSTRACT

In the present research work, an electro- hydraulic system was designed, constructed, and installed on a Massey Ferguson (MF) 285 tractor to be operated by applying a newly adapted hitch control valve. The electro- hydraulic system consisted of a tensile load cell, a potentiometer, a PLC, a stepper motor with its driver, hitch control valve and a programmable terminal. The experiment results showed that the performance of the electro-hydraulic control system was satisfactorily responsive to the draft force variations and the position of plow was altered in proportion with the draft force. Furthermore the control system was stable when the draft force was kept in a predetermined constant value. The results also showed significant differences between the two control systems in fuel consumption and wheel slip ($P < 0.05$). The use of the new electro- hydraulic draft control system decreased the fuel consumption and slippage by 44.6% and 29.3% respectively. This was when the tractor was set at its maximum draft and ground speed values and when compared with the previous mechanical draft control system.

Keywords: Tractor, Electro-hydraulic draft control, Tractive efficiency, Fuel consumption.

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Effects of Different Drying Methods on the Quality and Quantity of the Essential Oil in al (*Tanacetum Parthenium L.*)

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ABSTRACT

Plant essential oils are used in a wide range of pharmaceutical, food, cosmetics and hygienic products. To investigate the effects of different drying methods on drying time, essential oil content and the composition of feverfew (*Tanacetum parthenium L.*), an experiment was conducted in a randomized complete design of three replications. Three levels of microwave power (360, 540, and 720 w), three oven temperature levels (40, 50 and 60 °C), and two natural drying methods (sunshine and shade drying) were assessed and compared. Results showed the significant effects of drying methods on the essential oil contents and their percentages in the samples. The highest essence content was obtained in the case of shade drying and at 40 °C amounting to 76 and 74 %, respectively whilst the lowest one found to be 32 % related to 720 w microwave methods. Among the 27 components identified in the essential oils of feverfew (*Tanacetum parthenium L.*), camphene, camphor, Bornyl acetate, Germacrene and Cyclopentadiene were the major components, respectively. The highest level of camphene was obtained for oven temperature of 50 °C while the other various microwave power values markedly reduced the quantity of this compound.

Keywords: Drying, Essential oil, Microwave, *Tanacetum parthenium L.*

A survey on Potential of Biogas Production from Livestock and Rural Wastes using GIS, Kurdistan Province

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ABSTRACT

Biogas is a source of renewable energy, produced through the decomposition of organic matter by bacteria under anaerobic conditions. In order to find out the appropriate location(s) for establishment of biogas producing units, the availability of organic wastes as well as estimation of its quantity over the area must be taken into consideration. The present study addresses the questions on how the utilization of such information as rural and livestock population, applicable land maps, and Geographic Information System (GIS) could be employed to develop a model for an evaluation of biogas production out of livestock manure and rural wastes in Kurdistan Province. The model could be employed to figure out the appropriate locations for construction of biogas producing, and extraction units. The results obtained indicated that 110.622 MMC of biogas could be annually produced using livestock manure and rural wastes in Kurdistan Province which might be a proper replacement for the conventional energy and lead to a reduction of the harmful environmental impacts. The results also show that Saqqez with 21.586 MMC and Dehgolan with 6.730 MMC per year possess the highest vs. the lowest biogas production potential in Kurdistan Province respectively. In addition, the site suitability map of biogas plant was prepared by considering such technical and environmental aspects like proper distance from natural reserve places, water resources, building sites, and roads.

Keywords: Anaerobic digestion, energy, environment, livestock manure, wastes.

Analysis and Modeling of Alfalfa Energy and Production Cost using Multi-layer Adaptive Neuro-fuzzy Inference System in Bukan Township

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ABSTRACT

Energy is a fundamental determining component in the process of economic development the optimal use of which in sustainable agriculture is of prominent importance. In the present study the pattern of energy consumption in the production of alfalfa, the economic analysis and modeling of energy, as well as the production costs of the crop are surveyed in Bukan Township. Data were collected through interviews and filling up of specialized questionnaires. The results revealed that the total input vs. output energies respectively equaled 185658 and 232567.6 (Mj/ha). Electricity with a share of 75% of the total input energy was top most widely used input. Indicators of energy efficiency, energy productivity, benefit-cost ratio and economic productivity were recorded as 1.23, 0.08 kg/Mj, 2.07 and 0.000194 kg/rial respectively. The total cost of alfalfa production was 50065000 rial/ha the highest items of which were related to labor and machinery operations with 66.5% and 9.7% of the total, respectively. A comparison of modeling results using two methods of k-fold and C-means revealed that C-means method benefits from a higher accuracy in the prediction of energy productivity and production cost of the crop alfalfa. Results finally revealed that Energy productivity and production costs incurred by seed, irrigation water, electricity, chemical fertilizers, and animal manure, labor, pesticides, diesel fuel and machinery are predictable with high accuracy through on application of multi-layer adaptive neuro-fuzzy inference system.

Keywords: Alfalfa, Bukan Township, Energy Efficiency, Benefit-cost ratio, Modeling by ANFIS.