



Analysis of energy input and output for honey production in Iran (2012–2013)



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ABSTRACT

The objectives of this study were to determine the energy consumption and evaluation of inputs for honey production in Shahrekord city in the Chaharmahal Va Bakhtiary province, Iran to investigate the efficiency of energy consumption and to make an economic analysis of honey production. Data used in this study were obtained from 80 beekeepers using a face to face questionnaire method. The sample bee keepings were selected through a stratified random sampling technique. The following results were obtained at the end of the study: with 54.43% the input of sugar is the highest within the energy equivalences of input used in honey production. This is followed by electricity and transportation with 14.02% and 13.84%, respectively. The total energy inputs, total energy outputs, input–output energy ratio and productivities were $28941.51 \text{ MJ hive}^{-1}$, $15264 \text{ MJ hive}^{-1}$, 0.54 and 0.04, respectively. The results indicated that all of the inputs affected the yield significantly, except electricity. The fuel ($2815.5 \text{ MJ hive}^{-1}$) and sugar ($15292.2 \text{ MJ hive}^{-1}$) were affected significantly with 0.547 and 0.459 coefficients, respectively. The input–output energy ratio shows that the inputs used in the production of honey are not used efficiently. Extension activities are needed to improve the efficiency of energy consumption in honey production and to employ environmentally friendly agricultural management practices and production methods.

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1. Introduction

Cave paintings depicting honey harvesting dating from about 7000 B.C. have been discovered in Spain [8]. Commercial production of honey with 80% [25] sugar content is relatively efficient for human consumption in comparison with sugar cane or sugar beet production [28]. From that time, the beekeeping was interested for food production for human and the man looking for

knowledge of taking maximum advantage from it and its products. Honey (with 3040 kcal/kg energy value) is a useful source of high-carbohydrate food, and usually contains a rich diversity of minor constituents (minerals, proteins, vitamins and others), adding nutritional variety to human diets. In many countries, honey is regarded more as a medicine or special tonic, rather than as an every-day food. Honey does have medicinal properties that are increasingly acknowledged by modern medicine. In Iran, beekeeping and honey use and production has a long history. By means of the development of beekeeping in Europe and the import of modern hives and hybrid female queens (1956), Iranian enthusiasts became interested in the establishment of large

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beekeeping units. Iran ranked fourth in number of colonies of honey, with about 5,600,000 colonies, and eighth in honey production in the world. Annually, in Iran about 71,000 and 250 t of honey are harvested and per capita consumption of honey is about 610 g per person. In Shahrekord about 116,000 and 104 kg of honey from 25,000 colonies are harvested each year [Agricultural Organization of Province]. There are 19884 ha fields of forage plants such as alfalfa, sainfoin and clover in the region, caused that the area is suitable for beekeeping. The colonies in summer countryside are deployed in Astragalus fields and in spring and flowering time of trees and plants, would be established in farms, orchards and gardens in the vicinity of the Zayanderood river. Beekeepers in autumn and winter migrate to neighboring tropical provinces. Honey harvest begins in early August. Keeping bees is in wooden hives. All processes during the beekeepers, as is typical and traditional and harvesting honey are carried out by traditional means (ex. smoke generators, electric or manual extractor).

In the past decades, the commercial production of honey for human consumption is relatively efficient compared with the production of cane and beet sugar [29]. honey production requires large fossil energy inputs to provide the necessary equipment and supplies. The cane and beet sugar require about 2–3 times more energy to produce than honey [29]. The annually input energy for a commercial beekeeping in USA with 1000 colonies was measured. In that study, the total energy spent in production was 450.77 GJ and in maintenance and packaging was 64.4 GJ. The output energy for 45 t of honey was 572.4 GJ [28].

Worldwide, energy analysis studies have been conducted by researchers to determine the energy efficiency spent in the production process [10,14,16–24,30]. For this purpose, they have determined the contribution of each energy input, energy productivity, the specific energy, output–input energy ratio, net energy gain and the contribution of different energy forms, including direct, indirect, renewable and non-renewable. The efficient use of energy is one of the principal requirements of sustainable agriculture. Energy use in agriculture has been increasing in response to the increase of population, limited supply of arable land, and a desire for higher standards of living. The continuous demand for the increase of food production resulted in intensive use of chemical fertilizers, pesticides, agricultural machinery, and other natural resources. However, intensive use of energy causes problems threatening public health and environment. Efficient use of energy in agriculture will minimize environmental problems, prevent destruction of natural resources, and promote sustainable agriculture as an economical production system. In this study the input and output energy of honey production in Shahrekord were calculated and energy indexes, the most commonly used inputs and their effects coefficients in yield were analyzed.

2. Materials and methods

Data were collected from 80 beekeepers in Shahrekord, the capital of the Chaharmahal Va Bakhtiari province, Iran, by using a face-to-face questionnaire performed during winter 2012 and summer 2013 because of its one of major contributions to honey production in Iran by 6.1% of national production. In addition some data were obtained from the province's Beekeepers Association. Beekeepers that are producing honey were recorded, the total amounts of sugar and numbers of colonies (300–2000) were determined. Random sampling of beekeeping was done within the whole population and the size of each sample was determined

using Eq. (1) derived from the Neyman method [31,22]:

$$n = \frac{(\sum N_h S_h)}{N^2 D^2 + \sum N_h S_h^2} \quad (1)$$

where n is the required sample size; N is the number of holdings in target population; N_h is the number of the population in the h stratification; S_h is the standard deviation in the h stratification, S_h^2 is the variance of h stratification; $D^2 = d^2/z^2$ where d is the precision ($\bar{x} - \bar{X}$) and z is the reliability coefficient ($z=1.96$ which represents the 95% reliability). For the calculation of sample size, criteria of 5% deviation from population mean and 95% confidence level were used. The sampling size was considered as $n=80$. The samples were selected randomly and data were collected in MS Excel. In this region, the honey production inputs are human labor, machinery, diesel fuel, drug, sugar and electricity. The output was honey. The quantity of the various inputs used and the production outputs were calculated per hives, based on the information obtained from the questionnaires. The energy equivalent of inputs and output are showed in Table 1 and the most commonly used operations and practices in honey production in the studied region are listed in Table 2. In Asia there is a greater variety of honey bees, three representative species all being widely distributed: *Apis cerana*, *Apis dorsata* and *Apis florea*. *Apis cerana*, the native hive bee of Asia, is very similar to *Apis mellifera* but slightly smaller [7]. In studied region, in addition to *cerana* and *mellifera*, *ligustica* and *carnica* subspecies are also kept.

By using the equivalent energy of inputs and outputs, input and output energies of honey production were calculated. Based on the calculated energy of inputs and produced honey, the energy ratio (energy efficiency), specific energy and energy productivity were calculated [2,15]:

$$\text{Output – input ratio} = \frac{\text{Energy output}}{\text{Energy input}} \quad (2)$$

Table 1
The energy equivalent of inputs.

Input/output	Unit	Energy equivalent (MJ unit ⁻¹)	Reference
Inputs:			
Labor	h	1.96	[33, 23, 26, 5, 10]
Fuel	l	56.31	[33, 12, 4, 5, 1]
Electricity	kW h	11.93	[26, 20, 10, 21]
Track	km ton	10.15	[9]
Drug	kg	13.64	[19]
Sugar	kg	15.4	[6]
Output:			
Honey	kg	12.72	[28, 3]

Table 2
Practices and operations for honey production.

Practice/operation	Description
Bee subspecies	ligustica, carnica, mellifera, cerana
Location of the hives establishment	Alfalfa and astragalus fields (in winter) and orchards (in summer)
Transports type	Track
Cooling equipment	Water Cooler, Fan
The number of bee colonies	300–2000
Drug	Pesticides, Coumaphos
Spraying device	Traditional pump spray
Extractor type	Electric and manual
Hive types	Wooden
Working temperature (Celsius)	8–34
Distance between hives (Centimeters)	40–150
Time to replace the queen	In spring or in disability
Food in winter	Honey syrup, Sugar syrup

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