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Research Article
Current Status of Beekeeping in the Arabian Countries and Urgent Needs for its Development Inferred from a Socio-economic Analysis

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Abstract

Beekeeping is a dynamic activity and is impacted by many factors. A comprehensive survey was done from September, 2013 to April, 2015 to understand the current status of beekeeping in the Arabian countries and to identify the urgent needs for beekeeping development. Modern social communication means were utilized to perform the survey. Total of 138 respondents had participated in the study from 14 Arabian countries. Most of the respondents were with age from 31-45 years old (42.8% of the total). The most of them were also with high educational level with B.Sc. or higher degree (81.2% of the total) and 58.7% of them were with experience less than 10 years in beekeeping. The majority of the respondents preferred the indigenous bee races over the imported ones and 51.4% of them were only honey producers. The incorrect management of bee colonies was considered by the majority of the respondents as the most important factor behind death of the bee colonies. It could be concluded that planned training programs on beekeeping are highly required. The roles of the extension agencies are very essential to prepare suitable training programs for beekeepers. The use of the indigenous bee races in beekeeping should be supported. Effective laws and legislations to prevent honey adulteration and organize honey marketing issues are recommended to be done. Information about beekeeping in many Arabian countries are not available. Therefore, the results of this study can be considered as a baseline for any future investigations.

Key words: Honey bees, beekeeping, arabian countries, extension, varroa mites, beewolf

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Beekeeping is an important activity to agriculture, food security and biodiversity as well as it participates in reducing poverty and boost livelihoods in rural areas worldwide (Chazovachii *et al*., 2013; Gupta *et al*., 2014). It also contributes in the agricultural production due to the essential role of honey bees, *Apis mellifera*, in plants pollination as the pollination of more than 90 crops depend mainly on honey bees (Partap *et al*., 2012). About 15 billion dollars have been estimated as pollination value of honey bees in the USA alone in 2000 (Morse and Calderone, 2000). Moreover, honey bees participate in the conservation of the biodiversity for many crops beside their valuable nutritional and medicinal products including; honey, royal jelly and other bee products (Klein *et al*., 2007) which are considered as source of income (Qaiser *et al*., 2013).

Beekeeping is being practiced in all the arabian countries (AC) and is very old in Egypt about 5000 years ago. There are two main types of beehives in the AC, langstroth and traditional log hives (Hussein, 2000; Alqarni *et al*., 2011). Each AC has indigenous (native) bee race, for examples; *Apis mellifera lamarckii* in Egypt (Sheppard *et al*., 2001), *Apis mellifera jemenitica* in Yemen and Saudi Arabia (Alqarni *et al*., 2011) and *Apis mellifera syriaca* in Syria (Zakour and Bienefeld, 2014). But these indigenous races have been replaced or hybridized by other imported ones mainly *Apis mellifera carnica* as has happened in Egypt (Sheppard *et al*., 2001; Kamel *et al*., 2003). Other countries, mainly in the Arabian Gulf, for example in Saudi Arabia beside keeping honey bees in the traditional beehives, honey bees in modern langstroth beehives are imported from Egypt (Al-Ghamdi and Nuru, 2013). That caused high degree of hybridization between imported and indigenous bees (Al-Ghamdi *et al*., 2012). The impacts of the imported bees on current beekeeping in the AC need to be investigated. Since the last review article by Hussein (2000), there is no updated comprehensive information about beekeeping in the AC. Although the huge area of the AC with rich flora to honey bees e.g., (Alghoson, 2004; Abou-Shaara, 2015) the total production in all the AC of honey represents only 1.4% of the world production (FAO., 2012) which suggests the presence of some obstacles facing beekeeping in the AC. Such obstacles need to be highlighted to assist the responsible authorities in boosting beekeeping in the AC.

On the global level, there are many problems facing beekeeping activities including, diseases and pests to honey bees (Ritter and Akratanakul, 2006), losses of honey bee colonies during winter (Nguyen *et al*., 2010; Spleen *et al*., 2013), bee poisoning with pesticides (Johnson, 2015) and recently the mass diseasperance of bee colonies which known as colony collapse disorder (VanEngelsdorp *et al*., 2009). Simillar problems have been also reported in the AC, for example the presence of different honey bee pests and diseases (Al-Chzawi *et al*., 2009; El-Niweiri *et al*., 2009) and the death of colonies during summer (Abou-Shaara *et al*., 2013). The importance degree of such problems to current beekeeping in the AC need to be identified. Therefore, the study aims to use socio-economic analysis to identify the current status of beekeeping in the AC and to highlight the common and serious problems facing Arabian beekeeping. In light of the obtained results suitable solutions to cope with the detected problems were suggested and the necessary actions towards more developed beekeeping were recommended.

MATERIALS AND METHODS

Sampled countries and targeted group: The study included 14 Arabian countries, 9 of them are located in Asia; Jordan, Saudi Arabia, Sudan, Iraq, Yemen, Oman, Palestine, Qatar and Lebanon and 5 in Africa; Egypt, Libya, Morocco, Tunisia and Algeria. These countries have a huge area as shown in Fig. 1. Beekeepers (both non-professional and professional) and specialists (perform studies on beekeeping) are the target group in this study, especially those with the ability to use modern social communication means. The study was conducted from September, 2013 to April, 2015.

Questionnaire: A form (questionnaire) was prepared to contain different questions about beekeeping. The form contained five main sections; Section 1: Characteristics of respondents (country, age, educational level, work type, experience years, annual mean of honey production per colony and apiary type). Section 2: Economic benefits from beekeeping. Section 3: Pests and diseases of honey bees (included 11 pests and diseases and answering options were available to this section according to the importance as; not important, with less importance, with moderate importance, with high importance and unknown). Section 4: Potential reasons for colonies death. Section 5: Problems and obstacles (high temperature during the summer, low temperature during the winter, pests and diseases, dependence degree on the imported bees, training needs, honey adulteration, impact of imported honey on local honey market, lack of laws and legislations, bee poisoning with pesticides and high

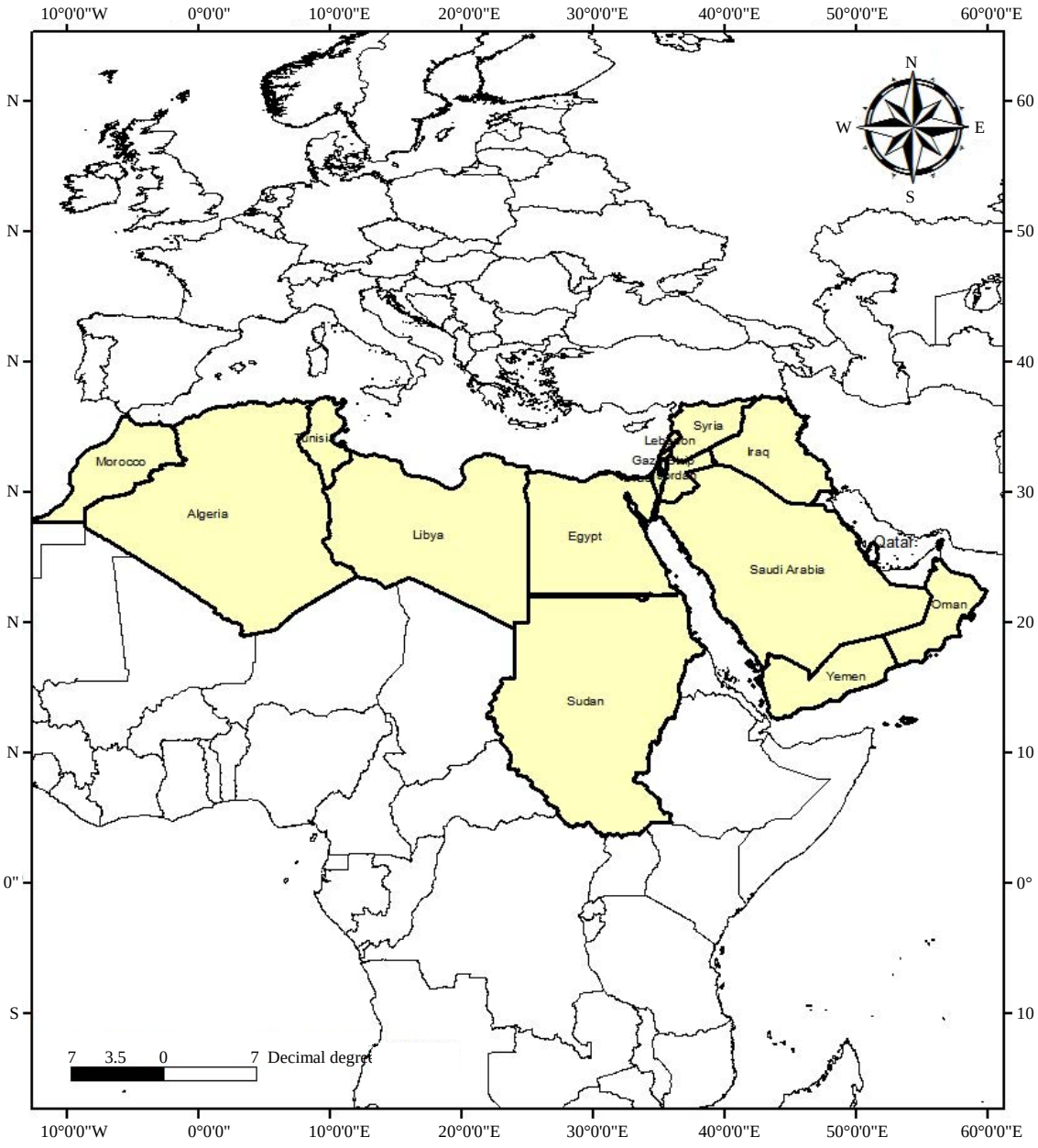

Fig. 1: Map shows the included Arabian countries in the study (countries with yellow color)

production costs) these points were measured as; not important, with less importance, with moderate importance and with high importance. Prior the distribution of this questionnaire, it was tested by members of Baqushan's chair of bee research in Saudi Arabia to make any necessary corrections and to evaluate it.

Data collection: Electronic communication techniques were used to collect the data. Google doc. was used to build up the questionnaire. The questionnaire was then distributed to reach as much beekeepers as possible using e-mail database of Arabian beekeepers available from Baqshan's chair for bee research in Saudi Arabia.

Statistical analysis: Before data analysis, any random answer not from the available options, in case of questions with answering options, was not included in the analysis. For questions with answering options, the 4th and 5th likert scales were used to give code for the answers according to the question type; 4 and 5 answering options, respectively. The

qualitative analysis, frequencies, correlations and reglations of the data were then performed using SPSS (2006). Means and Standard Deviations (SD) for some factors were calculated, then analysis of variance (ANOVA) was performed and means were compared using Duncan's multiple range test using SAS (2006) at significance level of 0.05.

RESULTS AND DISCUSSION

Characteristics of the respondents

Social characteristics of the respondents: The total number of respondents was 138 (Table 1) most of them were from Saudi Arabia with 16.67% of the total followed by Yemen, Iraq, Egypt, Algeria, Libya, Morocco, Oman, Tunisia, Jordan, Sudan, Palestine, Lebanon and Qatar with 15.21, 14.49, 10.86, 8.69, 7.24, 5.79, 5.07, 4.34, 3.62, 2.89, 2.89, 1.45 and 0.72% of the total, respectively. The social characteristics of the respondents showed that the age mean of them ranged from 31.25±5.74 years old in Sudan to 46.50±14.85 years old in Lebanon with overall mean of 39.36±4.89 years old. The respondents from Jordan, Algeria, Saudi Arabia, Sudan, Morocco, Yemen, Oman and Qatar were with age mean less than 40 years old while the respondents from the rest of the countries were with age mean higher than 40 years. Respondents from Iraq, Oman, Palestine, Lebanon, Libya and Egypt were with experience mean more than 10 years in beekeeping while those from the rest of the countries were with experience mean less than 10 years. The higher percentage of the respondents with higher education (B.Sc. or higher) was from Yemen, Iraq and Saudi Arabia while, the lowest percentage was to respondents from Lebanon and Qatar.

Table 2 shows that most of the respondents were with age from 31-45 years old (42.8% of the total) while those above 45 years old represented only 28.9%. The most of them were also with high educational level with B.Sc. or higher degree (81.2% of the total). Most of them (58.7%) with experience less than 10 years, of them 35.5% with experience less than 5 years in beekeeping. Most of the respondents are professional beekeepers (45.7% of the total). These results reflected that the respondents under 45 years old were the most users to e-communication than older ones. Most of them were with moderate experience in beekeeping (less than 10 years). The number of the respondents varied from country to another and the lowest participation was to Qatar and Lebanon.

Honey bees and apiary type: Most of the respondents (51.4% of the total) kept the indigenous (native) honey bees in their apiaries while 48.6% of them kept the imported honey bees (Table 3). The results in the same table also showed that the indigenous bees are preferred by the respondents over the imported ones in regard to colonies productivity, bees resistance to environmental conditions, resistance to pests and diseases and colonies management by 51.4, 87, 85.5 and 52.2%, respectively. Moreover, most of the respondents had apiaries with no migratory activities followed by apiaries with some migratory activities and finally migratory apiaries with 43.5, 34 and 22.5%, respectively. Previous studies in some Arabian countries found that the indigenous bees had more tolerance than imported ones to the local environmental conditions. For example in Saudi Arabia, the Yemeni honey bees (the indigenous bees) had more tolerance to heat stress than the imported ones as found by Alqarni (2006) and Abou-Shaara *et al.* (2012) which supports the respondents,

Table 1: Social characteristics of the respondents from the sampled Arabian countries (percentage of beekeepers with higher education was calculated as percentage of the total number of respondents = 138)

Country	No. of the respondents	Age (Mean±SD)	Experience in (Mean±SD)	Percentage of respondents with higher education
Jordan	5	39.40±14.04	8.60±4.04	2.89
Algeria	12	35.33±6.62	4.58±2.61	5.79
Saudi Arabia	23	39.50±10.42	9.65±9.22	12.32
Sudan	4	31.25±5.74	6.50±4.65	2.89
Iraq	20	46.45±11.08	16.10±10.88	12.32
Morocco	8	37.12±9.22	6.25±3.61	3.62
Yemen	21	34.86±7.01	8.67±5.05	14.49
Tunisia	6	42.00±1.73	8.67±6.03	3.62
Oman	7	37.83±6.27	11.57±6.80	3.62
Palestine	4	43.25±4.57	10.00±1.41	2.17
Qatar	1	32.00±0.00	5.00±0.00	0.72
Lebanon	2	46.50±14.85	19.50±10.61	0.72
Libya	10	42.40±9.37	15.60±9.11	6.52
Egypt	15	43.23±14.01	18.60±10.76	8.69
Overall mean±SD	138	39.36±4.89	10.66±4.92	5.74±4.52

Table 2: Categories of different characteristics of the respondents from the sampled countries

Criteria	Categories	Frequency	Percent
Age	Less than 16	0	0
	from 16-30	33	23.9
	from 31-45	59	42.8
	from 46-60	38	27.5
	more than 60	2	1.4
Education level	Only can read and write	4	2.9
	High school	22	15.9
	B.Sc.	76	55.1
	M.Sc.	23	16.7
	Ph.D.	13	9.4
Experience in beekeeping	Less than 5	49	35.5
	5-10	32	23.2
	11-15	26	18.8
	16-20	14	10.1
	More than 20	17	12.3
Relationship with beekeeping	Non-professional	35	25.4
	Professional	63	45.7
	Specialist	40	29.0

Table 3: Honey bee races and apiary type in the sampled countries

Questions	Options	Frequency	Percent
Does your country import honey bees?	No	71	51.4
	Yes	67	48.6
Are the indigenous bees better than the imported bees in regard to productivity?	No	67	48.6
	Yes	71	51.4
Are the indigenous bees better than the imported bees	No	18	13.0
in regard to resistance to the environmental conditions?	Yes	120	87.0
Are the indigenous bees better than the imported bees in regard to	No	20	14.5
pests and diseases resistance?	Yes	118	85.5
Are the indigenous bees easier to be managed than the imported ones?	No	66	47.8
	Yes	72	52.2
Apiary type	Non migratory	60	43.5
	Migratory	31	22.5
	Non migratory and migratory	47	34

opinion in regard to the preference of the indigenous bees than the imported ones due to their high adaptability to the local conditions. But in regard to colonies productivity, the imported bees in some countries had higher productivity than the indigenous ones, for example in Egypt where the carniolan bees (the imported bees) had higher productivity than the native Egyptian bees (Page *et al*., 1981). Based on the obtained results, keeping the indigenous bees should obtain the necessary support from the responsible authorities.

Honey production per colony: The results showed that the highest honey production per colony was in Morocco with mean 14.08±6.48 kg per colony per year, followed by Libya, Lebanon, Egypt, Tunisia, Palestine, Algeria, Iraq, Jordan, Oman, Qatar, Sudan, Saudi Arabia and Yemen with 1.52, 4.08, 4.58, 5.08, 5.2, 5.33, 5.37, 5.48, 8.58, 9.08, 9.75, 9.98 and 10.34 kg less than honey production in Morocco, respectively (Table 4). Honey production per colony in the Arabian countries per year ranged from 1 kg as the minimum production in Saudi Arabia, Yemen and Iraq up to 25 kg in Libya and Algeria as the maximum production, with overall mean of 8.00±4.27 kg. Mean of honey production obtained from the respondents is relatively in line with previously determined production in some Arabian countries. In Saudi Arabia, mean obtained from the respondents was 4.10 kg and it was estimated by Adgaba *et al*. (2014) to be 4.36 kg for traditional hives. According to FAO (2012), Egypt occupied the first rank in regard to honey production with 5700 t represents 23.97% of the total production in the Arabian countries followed by Algeria and Morocco with 5320 and 3500 t, respectively. However, mean of honey production per colony in Egypt per year obtained from the respondents was less than honey production in Morocco, Libya and Lebanon. But the highest overall production in Egypt reported by FAO (2012) compared with all the other Arabian countries can be explained by the high number of bee colonies in Egypt. According to

Table 4: Minimum, maximum, and means±Standard Deviations (SD) of honey production (kg) per colony in the Arabian countries per year

		Honey production		
Country	No. of colonies (Mean±SD)	Minimum	Maximum	Mean±SD
Jordan	38.20±25.14	4	20	8.60±6.84
Algeria	38.36±36.80	3	25	8.75±6.49
Saudi Arabia	123.00±167.65	1	10	4.10±2.49
Sudan	25.00±22.91	3	6	4.33±1.53
Iraq	66.17±85.16	1	15	8.71±3.41
Morocco	75.57±79.85	3	20	14.08±6.48
Yemen	82.93±93.66	1	7	3.74±1.73
Tunisia	50.67±52.01	5	18	9.00±4.98
Oman	82.60±122.73	2	10	5.50±3.62
Palestine	38.00±23.15	4	18	8.88±6.30
Qatar	100.00±0.00	5	5	5.00±0.00
Lebanon	617.00±823.77	8	12	10.00±2.83
Libya	141.50±303.42	6	25	12.56±5.64
Egypt	680.83±808.15	3	15	9.50±3.18
Overall mean	154.27±212.59	3.5	14.71	8.00±4.27

Table 5: Stepwise linear regration, considering honey productivity per colony as dependant variable while each of educational level, country, drought and shortage of bee forage plants as independent variables

		Coefficients (a)				
		Unstandardized coefficients		Standardized coefficients		
Model		B	Standard error	Beta	t	Significance
1	(Constant)	13.301	1.814		7.331	0.000
	Educational level	-1.811	0.564	-0.299	-3.212	0.002
2	(Constant)	11.269	2.007		5.614	0.000
	Educational level	-1.721	0.555	-0.284	-3.098	0.003
	Country	0.261	0.119	0.202	2.198	0.030
3	(Constant)	14.372	2.499		5.750	0.000
	Educational level	-1.782	0.548	-0.294	-3.251	0.002
	Country	0.281	0.117	0.218	2.400	0.018
	Drought and shortage of bee forage plants	-1.047	0.516	-0.184	-2.031	0.045

a: Dependent variable (Honey productivity per colony)

Table 6: Questions related to benefits from beekeeping

Criteria	Options	Frequency	Percentage
Do you get profits from beekeeping?	No	17	12.3
	Yes	121	87.7
Do you produce other bee products	No	71	51.4
beside honey?	Yes	67	48.6
Do formal authorities participate in	No	124	89.9
increasing profit from beekeeping?	Yes	14	10.1
Are there markets for locally produced	No	70	50.7
honey?	Yes	68	49.3
Do you participate in honey exportation?	No	118	85.5
	Yes	20	14.5

Hussein (2000) Egypt had the highest number of colonies than all the Arabian countries. Honey production per colony in the Arabian countries, in general, still low and that could be explained by problems and obstacles facing beekeeping as shown in the next paragraphs.

Variations among the Arabian countries in regard to honey production per colony can be explained by linear regration in Table 5. Relationship between colony productivity and factors impacting it showed that each of country, educational level, drought and shortage in bee forage plants are the most impacting factors on honey productivity per colony in the Arabian countries per year. Country as factor had positive impact on honey production while the other factors had negative impact on honey production.

Benefits from beekeeping: Results in Table 6 showed that 87.7% of the respondents considered beekeeping as a project with economic benefits (profit) while only 12.3% of them considered it as project without profit. Most of the respondents were only honey producers (51.4%), while 48.6% of them produced other bee products beside honey. According to 89.9% of the respondents, the formal authorities had ineffective role in boosting beekeeping. The absence of markets for locally produced honey was reported by 50.7% of the respondents. The majority (85.5%) of the respondents did not participate in the exportation of bee products. The results reflected the fact that Arabian beekeepers still depend mainly on honey production. That could be explained by the absence

Table 7: Mean±SD and level of importance for pests and diseases according to the respondents from the sampled countries

		Pests and diseases (Mean±SD)										
Country	No.	1	2	3	4	5	6	7	8	9	10	11
Jordan	5	2.2±1.0	3.0±2.0	1.6±0.8	3.4±0.5	3.0±0.7	1.8±0.4	3.2±0.8	2.2±0.8	2.0±0.7	3.0±1.8	2.2±0.8
		Weak	Mod.	None	High	Mod.	Weak	Mod.	Weak	Weak	Mod.	Weak
Algeria	12	3.6±1.4	3.5±1.7	3.2±0.9	3.1±0.9	3.0±0.6	3.0±1.5	3.0±0.6	2.6±1.0	2.6±1.2	2.5±0.9	2.5±0.7
		High	High	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Weak	Weak
Saudi Arabia	23	2.7±1.3	2.8±1.8	3.5±0.5	2.7±1.0	3.0±0.8	2.9±1.4	2.8±1.1	3.1±1.0	2.4±1.0	2.8±1.2	3.0±1.1
		Mod.	Mod.	High	Mod.	Mod.	Mod.	Mod.	Mod.	Weak	Mod.	Mod.
Sudan	4	1.2±0.5	2.2±1.8	3.0±3.2	1.5±0.5	3.0±0.8	1.5±0.5	3.2±1.7	2.0±0.8	1.7±0.9	2.2±1.8	1.2±0.5
		None	Weak	Mod.	None	Mod.	None	Mod.	Weak	None	Weak	None
Iraq	20	2.2±1.2	2.6±1.8	3.2±0.7	2.5±0.7	2.1±0.7	1.9±1.0	3.3±0.6	2.5±1.2	2.2±1.0	1.9±1.2	1.9±0.7
		Weak	Mod.	Mod.	Weak	Weak	Weak	Mod.	Weak	Weak	Weak	Weak
Morocco	8	2.2±0.4	1.5±0.5	2.6±0.9	2.0±0.7	3.1±0.6	2.5±0.5	3.1±0.9	2.6±1.1	2.0±0.7	1.8±0.6	2.2±0.8
		Weak	None	Mod.	Weak	Mod.	Weak	Mod.	Mod.	Weak	Weak	Weak
Yemen	21	2.5±1.4	2.5±1.8	2.9±0.7	3.0±1.0	2.9±0.8	2.5±1.3	3.0±0.8	3.0±1.2	2.5±1.4	2.6±1.3	2.7±1.0
		Weak	Weak	Mod.	Mod.	Mod.	Weak	Mod.	Mod.	Weak	Mod.	Mod.
Tunisia	6	1.6±0.5	1.8±1.6	2.3±1.0	1.8±0.7	3.1±1.3	2.1±1.4	3.0±1.0	1.5±0.5	2.6±1.3	2.1±1.6	1.6±0.5
		None	Weak	Weak	Weak	Mod.	Weak	Mod.	None	Mod.	Weak	None
Oman	7	2.5±1.5	2.4±1.5	3.1±0.6	4.0±0.5	3.0±1.1	2.7±1.7	3.1±1.2	2.2±0.7	2.2±0.7	2.4±1.5	2.5±1.5
		Weak	Weak	Mod.	High	Mod.	Mod.	Mod.	Weak	Weak	Weak	Weak
Palestine	4	2.5±1.7	3.0±2.3	2.5±1.0	4.0±0.0	3.0±1.1	3.7±1.5	3.5±1.0	3.5±0.5	2.2±0.9	3.2±2.0	2.7±0.9
		Weak	Mod.	Weak	High	High	High	High	High	Weak	Mod.	Mod.
Qatar	1	1.0±0.0	1.0±0.0	4.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0
		None	None	High	None	None	None	None	None	None	None	None
Lebanon	2	1.5±0.7	3.0±2.8	2.0±0.0	3.5±0.7	2.5±0.7	2.0±1.4	4.0±0.0	2.0±0.0	2.0±0.0	1.5±0.7	1.5±0.7
		None	High	Weak	High	Weak	Weak	High	Weak	Weak	None	None
Libya	10	2.8±1.0	2.5±1.6	2.9±0.7	2.7±0.4	2.5±0.9	3.6±0.8	3.5±0.5	2.1±0.9	2.2±0.9	2.4±0.6	2.5±0.9
		Mod.	Weak	Mod.	Mod.	Weak	High	High	Weak	Weak	Weak	Weak
Egypt	15	2.3±1.0	3.0±1.9	3.2±0.7	3.6±0.6	2.6±1.0	2.6±1.1	2.8±1.2	2.2±1.1	3.5±1.1	1.9±1.2	3.5±0.9
		Weak	Weak	High	High	Mod.	Mod.	Mod.	Weak	High	None	High

1: Bee paralysis virus, 2: Other pests and diseases, 3: Bee eaters, 4: Hornets, 5: Wax moths, 6: Tracheal mites, 7: Varroa mites, 8: Sudden death of bee colonies , 9: Brood diseases, 10: Beewolf and 11: Nosema, Level of importance: High, moderate., weak and none, Mod: Moderate

of suitable training programs to encourage beekeepers to produce other valuable bee products (e.g., pollen, royal jelly and propolis). Thus, urgent training needs on production methods of different bee products are required. Also, the exportation of bee products is not common in the Arabian countries but the importation is very common, for example the rank of Saudi Arabia as honey importer is the 4th among world countries (USDA., 2013).

Pests and diseases: All the pests and diseases investigated were with high importance at least in one country except beewolf (Table 7). Beewolf (bee-killer wasp) was considered with weak or moderate importance by all the respondents from the sampled countries. The high importance was given to bee paralysis virus in one country (Algeria), the presence of other pests and diseases in 2 countries (Algeria and Lebanon), bee eaters in 3 countries (Saudi Arabia, Qatar and Egypt), hornets in 5 countries (Jordan, Oman, Palestine, Lebanon and Egypt), wax moths in one country (Palestine), tracheal mites in 2 countries (Palestine and Libya), varroa mites in 3 countries (Palestine, Lebanon and Libya), the sudden death of bee colonies in one country (Palestine) and brood diseases and Nosema in one country (Egypt). It is clear that the importance of bee diseases and pests had differed from country to another. In 1986 Varroa mites were recorded in Jordan and beekeepers approximately lost about 50% of their colonies (Haddad, 2011). However, the respondents from Jordan did not considered Varroa with high importance that reflects their current knowledge in dealing with it. Training needs on the control of pests and disease are strongly required to learn beekeepers modern control techniques in each country.

The overall means and level of importance of pests and diseases investigated (Table 8) showed that each of Varroa mites, bee eaters, hornets and wax moths were with moderate importance to beekeeping beside other pests and diseases. Each of tracheal mites, bee paralysis virus, Nosema, beewolf and brood diseases had low importance. No significant differences ($p>0.05$) were found among pests and diseases with moderate importance as well as among pests and diseases with low importance. However, significant differences

Table 8: Overall means±SD and level of importance of potential pests and diseases to Arabian beekeeping

Pest and diseases	Mean±SD	Level of importance
Varroa mites	3.08±0.96[a]	Moderate
Bee eaters	3.04±0.86[a]	Moderate
Hornets	3.04±1.01[a]	Moderate
Wax moths	2.88±0.92[ab]	Moderate
Other pests and diseases	2.68±1.77[bc]	Moderate
Sudden death of bee colonies	2.59±1.13[c]	Low
Tracheal mites	2.51±1.29[c]	Low
Bee paralysis virus	2.47±1.29[c]	Low
Nosema	2.43±1.04[c]	Low
Beewolf	2.39±1.30[c]	Low
Brood diseases	2.37±1.08[c]	Low

Means followed by the same letter are not significantly different according to Duncan's multiple range test$_{0.05}$

($p<0.05$) were found between pests and diseases with moderate importance and those with low importance. It could be said that the Arabian beekeeping is still suffering from Varroa mites, bee eaters, hornets and wax moths.

Potential reasons behind the death of honey bee colonies: The importance of the potential reasons behind colonies death differed from country to another (Table 9). Three reasons only were considered by the respondents with high importance while all the other reasons were considered with moderate or weak importance. The incorrect management of bee colonies was considered with high importance in Oman, while drought and shortage of bee forage plants were with high importance in Saudi Arabia and Libya and the high temperature in the summer was highly important in Oman, Qatar and Libya. It is clear that the differences in the environmental conditions among the sampled countries impacted the importance degree of the investigated reasons. The weather in the Arabian deserts (mainly the Arabian Gulf and Libya) is semi-arid and very hot during the summer. That could explain why the drought, shortage of bee forage plants and the high temperature during the summer were with high importance in these countries as potential reasons behind colonies death. The other reasons were considered weak or moderate in their importance and that according to the respondents experience in beekeeping and the role of the responsible authorities in supporting beekeeping.

Table 10 shows the potential reasons of colonies death can be arranged in descending order according to the respondent answers as; the incorrect management of bee colonies, poisoning of bees with pesticides, pests and diseases, drought conditions and shortage of bee forage plants, high temperature in the summer and finally low temperature in the winter. All of these reasons had moderate importance. The incorrect management of bee colonies as well as poisoning of bees with pesticides differed significantly ($p<0.05$) only than low temperature during the winter, but no significant differences ($p>0.05$) were found between them and the other reasons. According to the respondents, the incorrect management of bee colonies followed by poisoning of bees with pesticides were expected to be as key potential reasons for colonies death. It could be expected that the incorrect management of bee colonies was due to the lacking of experience of some respondents as 35.5% of them with experience less than 5 years. It could be said that training needs on colonies management are strongly required. Also, decision makers should have key role in organizing the use of pesticide in the agriculture to protect bee colonies and the environment as well.

Problems and obstacles: The importance of the investigated problems and obstacles differed from country to another (Table 11). Training needs (i.e., lack of training programs) was considered with high importance in 8 countries (57.14% of the total) while high production costs as well as high temperature during the summer were considered with high importance in 5 countries (35% of the total). Drought and shortage of bee forage plants as well as negative impacts of the imported honey on marketing of the local honey were considered with high importance in 4 countries (28.57% of the total), while the other problems and obstacles were considered with high importance in only 3 countries or less. The respondents from Algeria and Tunisia did not consider any of the investigated problems and obstacles with high importance while those from the other Arabian countries considered 4 or less of the problems and obstacles investigated with high importance. It is clear that training programs are very important to boost beekeeping in the Arabian countries. It could be inferred from the answers of the respondents from Algeria and Tunisia that the role of the responsible authorities in solving beekeeping problems is somewhat effective and thus they did not consider any of the problems and obstacles with high importance. In general, most of the investigated points were either with high or moderate importance in the sampled countries and thus the participation of the responsible authorities to solve such problems is strongly required in each country.

Among the investigated problems and obstacles presented in Table 12, training needs (i.e., lack of training programs) had the highest level of importance followed by the other investigated points with moderate importance. Training needs differed significantly ($p<0.05$) than all the other inveistgated points, but no significant differences were

Table 9: Mean±SD and level of importance of the potential reasons for colonies death in the sampled countries

		Potential reasons for colonies death (Mean±SD)					
Country	No.	1	2	3	4	5	6
Jordan	5	2.2±0.8 Weak	3.0±1.2 Moderate	2.8±1.3 Moderate	3.2±0.4 Moderate	3.0±1.2 Moderate	2.6±1.5 Moderate
Algeria	12	3.0±1.0 Moderate	3.0±0.4 Moderate	2.6±1.0 Moderate	2.5±0.9 Moderate	2.0±0.9 Weak	1.9±0.9 Weak
Saudi Arabia	23	2.7±0.7 Moderate	2.8±0.8 Moderate	2.8±0.9 Moderate	3.0±0.9 Moderate	3.4±0.6 High	2.8±1.0 Moderate
Sudan	4	1.5±0.5 Weak	2.2±0.5 Weak	2.5±1.2 Moderate	3.2±0.9 Moderate	1.5±1.0 None	3.2±0.9 Moderate
Iraq	20	2.2±1.1 Weak	2.5±1.0 Moderate	2.7±1.1 Moderate	2.7±0.9 Moderate	2.5±1.2 Moderate	3.1±0.9 Moderate
Morocco	8	2.6±0.9 Moderate	2.7±0.7 Moderate	3.0±0.7 Moderate	3.2±0.7 Moderate	2.5±0.7 Moderate	3.1±0.8 Moderate
Yemen	21	2.7±0.8 Moderate	2.8±0.9 Moderate	3.0±0.8 Moderate	3.0±0.7 Moderate	2.9±1.0 Moderate	2.1±1.0 Weak
Tunisia	6	2.1±0.7 Weak	2.1±0.7 Weak	2.3±0.5 Weak	3.0±0.6 Moderate	3.0±0.6 Moderate	2.6±0.8 Moderate
Oman	7	2.2±0.7 Weak	2.5±0.7 Moderate	2.8±0.6 Moderate	3.4±0.5 High	3.0±0.8 Mod.	3.4±0.7 High
Palestine	4	2.5±1.0 Moderate	2.7±1.2 Moderate	3.0±1.4 Moderate	2.7±1.5 Moderate	2.5±1.0 Moderate	2.5±1.7 Moderate
Qatar	1	3.0±0.0 Mod.	1.0±0.0 None	1.0±0.0 None	1.0±0.0 None	2.0±0.0 Weak	4.0±0.0 High
Lebanon	2	2.0±1.4 Weak	2.5±0.7 Moderate	2.5±0.7 Moderate	2.5±0.7 Moderate	1.5±0.7 None	1.0±0.0 None
Libya	10	2.3±0.6 Weak	2.9±0.7 Moderate	2.7±0.9 Moderate	3.1±0.7 Moderate	3.4±0.4 High	3.3±0.8 High
Egypt	15	2.4±1.0 Weak	3.0±1.1 Moderate	3.1±1.9 Moderate	1.8±0.8 Weak	1.7±0.8 Weak	1.8±0.3 Weak

1: Low temperature in the winter, 2: Pests and diseases, 3: Poisoning of bees with pesticides, 4: Incorrect management of honey bee colonies, 5: Drought and shortage of bee forage plants and 6: High temperature in the summer, Level of importance: High, moderate, weak, none

Table 10: Overall means±SD and level of importance of potential reasons behind colonies death in the sampled countries

Potential reasons behind colonies death	Mean±SD	Level of importance
Incorrect management of honey bee colonies	2.91±0.89[a]	Moderate
Poisoning of bees with pesticides	2.83±0.96[a]	Moderate
Pests and diseases	2.75±0.89[ab]	Moderate
Drought and shortage of bee forage plants	2.66±1.10[ab]	Moderate
High temperature in the summer	2.65±1.11[ab]	Moderate
Low temperature in the winter	2.52±0.95[b]	Moderate

Means followed by the same letter are not significantly different according to Duncan's multiple range test$_{0.05}$

detected among points from 2-10 as well as from points 6-11, while all the points differed significantly than the last two points (lack of laws and legislations and dependence degree on the imported bees). The training needs as the major problem to the respondents can be considered as logical requirements, especially since they considered the incorrect management of bee colonies as important reason for colonies death. Also, they considered some bee pests and diseases with moderate importance as well as most of them produce honey only. These points reflected the lack of experience in bees management for most of the respondents, control strategies of bee pests and diseases and suitable techniques for producing various bee products. The other problems can be divided into three categories; (1) Production related problems including; high production costs, lack of skilled workers, pests and diseases of bees, dependence of beekeeping on the imported bees, deterioration of the indigenous bees, poisoning of bees with pesticides and lack of laws and legislations, (2) Honey marketing related problems including; honey adulteration and impacts of imported honey on local market and (3) Environmental related problems including; drought and shortage of bee forage plants, high temperatures during the summer and low temperature during the winter. Lack of laws and legislations was considered as a problem with moderate importance by the respondents, meanwhile the presence of specific laws and legislations by decision makers can be considered as a solution to many of the reported problems; including honey adulteration, importation of honey and bee products, problems related to imported bees and poisoning of bees with pesticides. Also, training needs on different beekeeping skills can help in solving each of production and environmental related problems. The extension agencies can play a great role in providing beekeepers with suitable training programs. Especially the role of the extension agencies has been reported to be very useful in solving beekeeping problems by providing suitable training for beekeepers (Ebojei *et al*., 2008; Matanmi *et al*., 2008). Also, the research organizations should have effective role in solving environmental related problems and to conserve the indigenous bees. It worth to mention that some studies were performed in different Arabian countries to protect the bee colonies from the unsuitable environmental conditions. In Saudi Arabia, Abou-Shaara *et al*. (2013) developed beehives to boost colonies survival during the summer where temperature could reach to 50°C while, in Egypt Omran (2011) developed beehives to enhance survival of bee colonies during the cold weather of the winter. Such trend of studies needs to be supported by decision makers and research organizations.

Table 11: Means±SD and level of importance for the potential problems and obstacles in the sampled countries

	Problems and obstacles (Mean±SD)												
Country	1	2	3	4	5	6	7	8	9	10	11	12	13
Jordan	3.4±0.5	3.4±0.8	3.4±1.3	3.2±0.8	3.2±1.1	3.2±0.8	3.0±1.0	3.0±1.2	2.8±1.1	2.6±1.5	2.6±1.1	2.4±1.1	1.6±0.5
	High	High	High	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.
Algeria	2.2±1.0	2.5±1.0	3.1±1.0	2.4±0.6	2.8±0.7	3.1±0.8	3.1±0.9	2.7±1.0	3.0±0.6	2.2±0.8	2.0±0.8	2.3±1.0	2.0±0.7
	Weak	Mod.	Mod.	Weak	Mod.	Mod.	Mod.	Mod.	Mod.	Weak	Weak	Weak	Weak
Saudi Arabia	3.3±0.7	3.3±0.7	3.0±0.9	2.8±0.7	3.4±0.5	3.6±0.5	2.8±0.8	3.1±0.8	3.2±0.7	2.8±1.0	3.0±1.0	2.5±1.0	2.6±1.1
	High	High	Mod.	Mod.	High	High	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.
Sudan	2.0±1.1	2.5±1.2	2.5±1.2	2.2±0.5	2.5±0.5	3.7±0.5	1.5±0.5	1.7±0.9	2.5±1.7	2.7±1.2	2.5±1.2	1.7±0.5	1.5±0.5
	Weak	Mod.	Mod.	Weak	Mod.	High	None	Weak	Mod.	Mod.	Mod.	Weak	None
Iraq	2.9±0.8	3.0±1.2	2.9±1.1	2.5±0.8	2.6±1.1	3.3±0.9	2.4±1.1	2.9±1.0	2.7±1.2	3.5±0.8	3.3±1.0	2.3±1.3	2.0±0.9
	Mod.	Mod.	Mod.	Mod.	Mod.	High	Weak	Mod.	Mod.	High	High	Weak	Weak
Morocco	2.6±0.9	2.8±1.3	3.5±0.7	3.0±0.7	3.1±0.8	3.8±0.3	2.8±0.9	3.1±0.9	3.3±1.0	3.2±0.4	2.3±1.3	2.2±1.0	1.5±0.5
	Mod.	Mod.	High	Mod.	Mod.	High	Mod.	Mod.	High	High	Weak	Weak	None
Yemen	2.9±0.7	2.9±0.9	2.7±0.8	2.8±1.0	3.0±1.0	3.4±0.6	2.6±0.9	3.1±0.7	2.7±1.0	2.2±1.0	2.3±1.0	2.2±1.0	1.7±0.3
	Mod.	Mod.	Mod.	Mod.	Mod.	High	Mod.	Mod.	Mod.	Weak	Weak	Weak	Weak
Tunisia	2.3±1.2	2.8±1.1	2.6±0.8	2.1±0.7	3.0±0.6	2.8±0.4	2.1±0.9	2.6±1.0	3.0±0.0	2.3±1.2	1.6±0.5	1.3±0.5	1.5±0.5
	Weak	Mod.	Mod.	Weak	Mod.	Mod.	Weak	Mod.	Mod.	Weak	None	None	None
Oman	3.1±1.2	1.7±1.1	3.0±1.1	2.7±1.1	3.2±0.7	3.1±1.2	2.2±1.1	2.2±1.3	2.2±1.3	3.7±0.4	2.7±1.2	3.0±1.1	2.2±1.1
	Mod.	Weak	Mod.	Mod.	High	Mod.	Weak	Weak	Weak	High	Mod.	Mod.	Weak
Palestine	3.7±0.5	3.0±0.8	3.2±0.9	3.0±0.8	3.7±0.5	3.5±0.5	2.5±1.0	3.0±1.4	2.5±1.0	2.5±1.2	2.5±1.0	2.5±1.2	1.5±0.5
	High	Mod.	High	Mod.	High	High	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	None
Qatar	3.0±0.0	4.0±0.0	3.0±0.0	3.0±0.0	2.0±0.0	2.0±0.0	3.0±0.0	2.0±0.0	2.0±0.0	4.0±0.0	2.0±0.0	3.0±0.0	4.0±0.0
	Mod.	High	Mod.	Mod.	Weak	Weak	Mod.	Weak	Weak	High	Weak	Mod.	High
Lebanon	3.0±0.0	3.5±0.7	2.0±1.4	2.5±0.7	2.0±0.0	2.0±1.4	2.5±0.7	3.0±1.4	2.5±0.7	1.5±0.7	3.0±1.0	2.5±2.1	2.5±0.7
	Mod.	High	Weak	Mod.	Weak	Weak	Mod.	Mod.	Mod.	None	Mod.	Mod.	Mod.
Libya	3.4±0.9	2.3±0.9	3.2±1.2	2.9±0.7	2.5±0.9	3.4±0.6	2.3±0.8	2.8±0.9	3.1±0.9	3.3±0.6	2.9±0.9	1.6±0.9	2.0±0.4
	High	Weak	High	Mod.	Mod.	High	Weak	Mod.	Mod.	High	Mod.	None	Weak
Egypt	2.8±0.8	2.2±1.2	3.5±0.8	3.0±0.9	2.8±1.0	3.4±0.7	3.1±0.8	3.0±1.0	3.4±0.8	2.2±0.9	3.3±0.8	2.6±1.1	1.8±0.9
	Mod.	Weak	High	Mod.	Mod.	High	Mod.	Mod.	High	Weak	High	Mod.	Weak

1: Drought and shortage of bee forage plants, 2: Negative impacts of the imported honey on marketing of the local honey, 3: High production costs, 4: Pests and diseases, 5: Honey adulteration, 6: Training needs, 7: Low temperature during the winter, 8: Poisoning of bees with pesticides, 9: Lack of skilled workers, 10: High temperature during the summer, 11: Deterioration of the indigenous bees, 12: Lack of the laws and legislations and 13: Dependence of beekeeping on the imported bees, Level of importance; High, Moderate, weak, none, Mod: Moderate

Table 12: Overall means±SD and level of importance for the potential problems and obstacles of the Arabian beekeeping

Problems and obstacles	Mean±SD	Level of importance
Training needs (i.e. lack of training programs)	3.38±0.77^{a}	High
High production costs	3.10±0.99^{b}	Moderate
Honey adulteration	2.97±0.93^{bc}	Moderate
Lack of skilled workers	2.95±1.00^{bc}	Moderate
Drought and shortage of bee forage plants	2.94±0.93^{bc}	Moderate
Poisoning of bees with pesticides	2.92±0.98^{bcd}	Moderate
High temperature during the summer	2.74±1.05^{cd}	Moderate
Deterioration of the indigenous bees	2.73±1.10^{cd}	Moderate
Pests and diseases	2.73±0.84^{cd}	Moderate
Negative impacts of the imported honey on marketing of the local honey	2.72±1.11^{cd}	Moderate
Low temperature during the winter	2.66±0.99^{d}	Moderate
Lack of the laws and legislations	2.32±1.12^{e}	Moderate
Dependence of beekeeping on the imported bees	2.03±0.95^{f}	Moderate

Means followed by the same letter are not significantly different according to Duncan's multiple range test$_{0.05}$

Training needs as main factor had low correlations (r values ranged from 0.14-0.36) with the investigated factors (Table 13). All the correlations were positive expect in case of factors; 1 (low temperature), 6 (resistance of the indigenous bees to pests and diseases) and 9 (colonies number). Also, all the correlations were significant except in case of factors; 2 (honey adulteration), 5 (incorrect management of bee colonies), 7 (lack of skilled workers), 8 (bee poisoning with pesticides) and 9 (colonies number) were strongly significant. Thus, it could be expected that suitable training programs can contribute in solving current beekeeping problems.

Table 13: Pearson correlation coefficients (r) between training needs and the other investigated factors

Factors	1	2	3	4	5	6	7	8	9
Training needs	-0.18*	0.29**	0.16*	0.18*	0.26**	-0.14*	0.36**	0.22**	-0.23**
Significance	0.02	0.00	0.03	0.02	0.00	0.05	0.00	0.00	0.01

Factors; 1: Low temperature, 2: Honey adulteration, 3: Drought, 4: High temperature in the summer, 5: Incorrect management of bee colonies, 6: Resistance of the indigenous bees to pests and diseases over the imported ones, 7: Lack of skilled workers, 8: Bee poisoning with pesticides and 9: Colonies number, *Significant, **Strongly significant

CONCLUSION

The study showed that e-communications can be used to collect data from beekeepers with different ages and educational levels from the Arabian countries. The responsible authorities and research organizations should support beekeepers to keep the indigenous bees in their apiaries instead of the imported ones. Due to the high adaptability of the indigenous bees to the local conditions in each country than the imported ones. Also, research efforts should be devoted to solve current beekeeping problems, mainly problems related to colonies productivity, honey marketing and unsuitable environmental conditions. Training programs on colonies management, production methods of various bee products and control methods of bee diseases and pests are strongly required. The extension agencies should play a key role in providing beekeepers with suitable training programs. Specific laws and legislations should be issued by decision makers to prevent honey adulteration, to organize honey marketing issues and to organize the use of pesticides in the agriculture to protect the bees and the environment as well.

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