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CONTENTS

NEGATIVE EFFECTS OF HIGH TEMPERATURE ON YIELD AND QUALITY OF CORN GENOTYPES

CHAPTER 1

Ali Beyhan UÇAK[1]
Murat ERMAN[2]

[1] Siirt University, Faculty of Agriculture, Department of Biosystem Engineering, Siirt /Turkey
Corresponding author's e-mail: abucak@siirt.edu.tr
[2] Siirt University, Faculty of Agriculture, Department of Field Crops, Siirt /Turkey

1. INTRODUCTION

Nature is the environment that is started to be used with the creation of human beings and meets all kinds of needs of human being. Mankind can make nature more useful, which may start with the exploration of the resources available in the world primarily according to the rules of nature. Fallowing the identification of important resources, studies conserving and improving the sustainability and fertility of these resources for the next generations start. The crops grown on earth are the most important sources for the world. Çukurova region, which consists of Adana, İçel, Hatay, Kahramanmaraş and Gaziantep provinces has 933,000 ha arable fertile land. Approximately 1 million tons of corn is produced in the region that corresponds to 43% of the total corn produced in the country.

The homeland of corn (*Zea mays* L.) is the American continent and the corn spread around the world after the discovery of this continent. The corn introduced to Turkey at around 1600 (Kün, 1997). The corn, which has a significant place in human and animal nutrition, ranks the third in the world after wheat and rice among the cereal cultivation and the second after wheat in production. The corn is an important raw material used in the industry to make starch, syrup, sugar, beer and alcohol (Süzer, 2003). The corn cultivation area in Turkey is approximately 522,000 ha, the production is 5200 tons and average yield is between 1000 and 1750 kg da^{-1}. The cultivation area in Adana is 122 thousand ha, the production is 1423 tons, and the yield is between 1200 and 1500 kg da^{-1} (average 1350 kg da^{-1}). Adana province ranks the first in corn production of Turkey (TUIK, 2018).

Corn has many varieties such as horse dent corn, hard corn, gin corn or popcorn and sugar corn, however, different horse dent corn varieties belonging to various FAO (World Food Organization) maturity groups were adopted by the farmers in Çukurova region and widely grown as the first and second crop. Çukurova is a plain with a Mediterranean climate which is characterized by hot and dry summer and mild and rainy winters. Severe summer droughts and high temperatures prevail in the Mediterranean climate, and the temperature often rises above 40 °C in summer days. The annual rainfall is between 600 and 700 mm which mostly occurs in winter and spring months (Anonymous, 2009a). Since no rainfall occurs in summer months, corn can only be grown in irrigated areas.

Similar to the other crops, biotic factors such as diseases, weeds and pests, and abiotic factors such as soil, fertilizer, irrigation, tillage and climate play an important role in corn production. Rainfall, temperature and relative humidity are the three most important elements of the climate. Climate is one of the most important restricting factors of crop production in agricultural areas (Kapur et al., 2008). In addition, Jones (2000) reported that atmospheric activities are highly effective in the yield, fertility and quality of agricultural products. Abiotic factors as well as biotic factors play a crucial role in corn production. Climatic events, among the abiotic factors, have direct and indirect influences on corn production (Öztürk, 2007). Çukurova region has been classified as semi-humid according to Erinç, semi-humid-semi-arid according to Thornthwaite and close to humid climate according to Koppen (FAO, 1997; Şensoy, 2007). The corn seeds start to germinate at 10-11 ºC. Germination is accelerated when the soil temperature reaches 15 ºC at a depth of 5-10 cm. Root and stem elongation length during the germination has a linear relationship with the temperatures between 10 and 30 ºC. Root and stem elongation sharply decrease when the temperature reaches 32 ºC, and the germinated plants die when the temperature reaches 40 ºC. Conversely, root elongation discontinues if the temperature drops below 9 ºC. The ideal temperature for corn production is between 24 and 32 ° C or no air conditioning is required at nights. Although corn is a temperate plant, it does not require extreme temperatures. When the temperature reaches 38 ºC, even under irrigation conditions, the plant cannot meet the water lost by transpiration through the roots and the plant loses the turgidity state. The cell structure loses its flexibility and cannot return to the original form when this condition persists for a few days (Cerit et al., 2001; Uçak and Saltuk, 2019). The aim of this study was to investigate the direct and indirect effects of climate on first and second crop corn yield in 2010 under conditions of Çukurova, which has a very important place in corn cultivation of the Mediterranean Region. The climatic data for 2010 were compared with the first and second corn yield values and interpreted accordingly.

Material and Methods

Çukurova is a fertile plain located in the Eastern Mediterranean region, with its fertile soils and Ceyhan and Seyhan rivers. The plain has a typical Mediterranean climate with hot and dry summers and mild and rainy winters. The field experiments were conducted in the research and experimental station of T.C. Ministry of Agriculture and Rural Affairs, Çukurova Agricultural Research Institute located in Doğankent town of Adana province.

The superior advantage of ecology enables several field crops to be grown in Çukurova. Corn (*Zea mays* L.) is one of the several field crops. In this study, MGM 134757, MGM 147484, MGM 131830, MGM 161278 corn cultivars belonging to Özel Seed Company and P 31G98, ADA 523, DKC 6589, NK ARMA corn cultivars as standards were used as plant material in the first crop corn experiment. MGM 173393, MGM 144697, MGM 157028 and MGM 116521 corn varieties belonging to Özel Seed Company and P 3394, P 32T83, DK 5783 and SHEMAL corn varieties as the standards were used as plant material in the second crop corn experiment.

Typical Mediterranean climate with mild and rainy winters and hot and dry summers is dominant in Adana province where the experiments carried out. Some climatic data of Adana province, recorded during the first and the second crop growing periods, for 2010 and long-term averages were given in Tables 1 and 2.

Table 1. *Climate data for the long term and 2010 of the first crop corn experimental site*

Months	Mean Temperature (°C)		Mean Humidity (%)		Total Precipitation (mm)	
	1990-2009	2010	1990-2009	2010	1990-2009	2010
April	16.6	18.6	73	69.8	48.3	89.3
May	20.9	22.4	68	74.4	31.5	56.6
June	25.9	26.1	66.6	71.2	16.9	4.8
July	28.3	28.5	71.9	76.9	9.4	0.7
August	28.8	30.8	71.2	74.8	7.5	0
September	26.2	28.3	65.2	73.6	17.2	1.7

Source: Records of the Regional Directorate of State Meteorological Services. Adana.

***1990-2009 Annual Mean Values**

The precipitation between April and September, 2010, which is the growing period of corn, was recorded as 153.1 mm and long-term average precipitation was 130.8 mm. In contrast, an increase in temperature and relative humidity was recorded in 2010 compared to the long-term averages (Table 1). The precipitation during the growing period of the second crop corn (between June and October in 2010) was 38.7 mm which was lower than the long-term average precipitation (74.9 mm). In contrast to the precipitation, an increase in temperature and relative humidity was noticeable (Table 2). The maximum temperature between June and October in 2010, when the experiment was conducted, was recorded between 34.6-40.6 ºC. These high values adversely affected the growth and pollination (fertilization) of corn plants.

Table 2. *Climate data for the long term and 2010 of the second crop corn experimental site*

Months	Mean temperature (ºC)		2010 Min.-Max. Temperature (ºC)		Mean Humidity (%)		Total Precipitation (mm)	
	1990-2009	2010	Min	Max	1990-2009	2010	1990-2009	2010
June	25.9	26.1	18.4	38.1	66.6	71.2	16.9	4.8
July	28.3	28.5	22.0	40.0	71.9	76.9	9.4	0.7
August	28.8	30.8	23.2	40.6	71.2	74.8	7.5	0
September	26.2	28.3	21.0	40.2	65.2	73.6	17.2	1.7
October	22.8	22.4	12.5	34.6	67.3	66.3	23.9	31.5

Source: Records of the Regional Directorate of State Meteorological Services. Adana.

***1990-2009 Annual Mean Values**

The experiment was laid out according to randomized blocks with four replications. The seeds of cultivars were planted as 70 cm interrow and 20 cm intrarow spacings with 4 rows in 20 m plot length. During planting, 9 kg phosphorus and 9 kg nitrogen (N) were applied per decare, and 15 kg N da^{-1} was applied as top fertilizer when the plants reached the 6-8-leaf period. During the experiment, necessary maintenance and cultural practices were carried out according to standard methods. After the necessary observations and measurements, harvesting was carried out by hand picking of cobs in the two middle rows of the plots. In addition, the moisture content of the grain was measured by an electronic moisture measuring instrument.

Agronomic Characteristics;

1. Duration of Top Tassel Emergence (day): The number of days between the planting date and the date when the top tassel emergence reached 50%.

2. Plant Height (cm): The distance between the soil surface and the origin of the first branch of the top tassel was measured in cm in 5 plants located in randomly selected 2 rows in each plot.

3. Hight to First Cob (cm): In each plot, the distance between the soil surface and the node that the cob emerged was measured in cm in 5 plants where the plant height was measured.

4. Grain Yield (kg da^{-1}): The grain obtained from the two rows in the middle of each plot was weighed and the moisture content was determined with a moisture meter. Then, the weight was corrected to 15% moisture level and yield was calculated as kg da^{-1}.

8.3. Statistical Evaluation of the Data

The data were evaluated using JUMP software by combined variance analysis and F-control according to a randomized block experiment design. Means were compared by an LSD-test.

3. Results and Discussion

1. Seed Yield of First Crop Corn

The difference between grain yields of hybrid corn varieties in first crop corn was statistically significant at 1% level (Table 3). Grain yields ranged from 1139 to 1448 kg da^{-1}, the mean grain yield of the standard varieties was 1320 kg da^{-1} and the overall mean grain yield was 1323 kg da^{-1}. The highest grain yield was obtained in P 31G98 hybrid corn cultivar, while the lowest grain yield was obtained from ADA 523 hybrid corn cultivar. The grain yields of MGM 147484 and MGM 131830 hybrid corn varieties were higher than the average of the standard varieties and the general average and these two varieties were placed in the same group with the highest yielding P 31G98 and DKC 6589 standard corn varieties.

Table 3. *Mean values of grain yield for the first crop corn varieties and groups determined by the LSD test*

No	Single Hybrids	Seed Yield* (kg da^{-1})
1	P 31G98	1448 a
2	DKC 6589	1396 ab
3	MGM 147484	1366 ab
4	MGM 131830	1345 ab
5	MGM 134757	1305 ab
6	NK ARMA	1299 ab
7	MGM 161278	1288 bc
8	ADA 523	1139 c
Mean for Standards		1320
General Mean		1323

LSD:171 **CV (%): 7.5**

*** No significant difference at the 0.01 level between the mean grain yields of varieties shown with the same letters.**

The values of the mean grain yield of hybrid corn varieties were given in Figure 1. The lowest seed yield was obtained from ADA523 and the highest seed yield was obtained from P31G98.

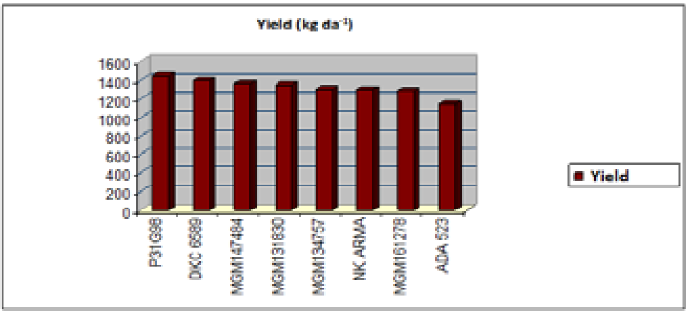

Figure 1. *Mean Grain Yields of Hybrid Corn Varieties*

2.Second Crop Corn Yield

The difference between the grain yields of the second crop hybrid corn varieties was significant at 5% level (Table 4). The grain yields ranged between 667 and 939 kg da^{-1}, the mean grain yield of the standard varieties was 822 kg da^{-1} and the overall mean grain yield was 765 kg da^{-1}. The highest grain yield was recorded in P 32T83 hybrid corn cultivar and the lowest grain yield was obtained from MGM 157028 hybrid corn cultivar. The grain yields of hybrid corn varieties MGM 173393, MGM 157028 and MGM 116521 were lower than the mean grain yield of standard varieties and the general average. The grain yield of MGM 144697 was higher than the general average and the standard P3394 corn variety. Therefore, the MGM 144697 variety was placed in the same group of the DK 5783 variety. Temperatures above 40 °C in July, August and September adversely affected the growth and fertilization of the varieties and significantly affected the yield performance of the varieties.

Table 4. *Mean values of grain yield for the second crop corn varieties and groups determined by the LSD test*

No	Single Hybrids	Seed Yield* (kg da^{-1})
1	P 3394	714 c
2	P 32T83	939 a
3	DK 5783	749 bc
4	SHEMAL	889 ab
5	MGM 173393	716 c
6	MGM 144697	772 bc
7	MGM 157028	667 c
8	MGM 116521	674 c
Mean for Standards		822
General Mean		765

LSD:192 **CV (%): 15.4**

*** No significant difference at the 0.05 level between the mean grain yields of varieties shown with the same letters.**

Mean grain yields of hybrid corn varieties were given in Figure 2. The lowest grain yield was obtained from MGM 157028 and the highest grain yield was obtained from P 32T83 variety (Figure 2).

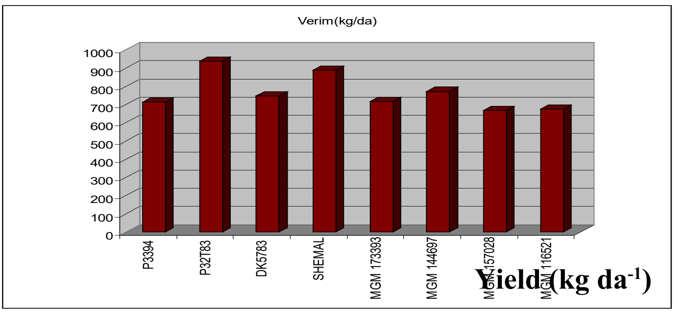

Figure 2. *Mean Grain Yields of Hybrid Corn Varieties*

3. Effects of Temperature and Relative Humidity on Cron Plant

Soil is not a limiting factor, since corn can grow in almost any type of soil. However, the most important factors limiting corn cultivation are high temperature, precipitation and very high and low humidity values. The first crops in Çukurova are cultivated in late March and April. The second crop corn planting starts in the first half of June with the abandonment of the first crop and continues until the end of the month. Depending on the temperature and humidity of the maturity groups, the top tassel begins to emerge after about 55-60 days and the ear tassels emerge within 2-3 days. The period in which the second crop corn started to be fertilized in Çukurova corresponds to the first week of August. Extreme temperatures and low humidity during the flowering period significantly affect corn growth. Therefore, the correlation between climate data and yield in 2010 was investigated. The findings showed that climate values in 2010 had an adverse effect on corn yield. The second crop corn in Çukurova starts to be fertilized from the first week of August and continues till the end of the month. Therefore, instead of examining the month of August on a monthly basis, examining the days of the month corresponding to fertilization will be useful to assess the effect of climate on yield.

The high temperature, low relative humidity and the resulting drought in mid-August 2010 were the main reasons for the decrease in corn yield. The first crop corn sowing date was 13.04.2010 and the anthesis period started about 56 days after (01 June 2010) the planting. In this context, the yield was not adversely affected as there were no extreme temperatures in June (Appendix Table 1). However, the second crop corn sowing date was July 01 and anthesis period started 48 days after the planting, i.e. between 17 and 19 August (Appendix Table 2). The air temperature reached the maximum value on the dates mentioned in August. The high temperature in August led to a 42% decrease in yield in the second crop compared to the first crop. The mean yield was 1323 kg da^{-1} in the first crop while it was 765 kg da^{-1} in the second crop; therefore, the yield reduction in the second crop was 558 kg da^{-1}.

High temperatures up to 40˚C and relative humidity values around 30-40% have negatively affected the fertilization. Thus, the fertilization period was shortened, sufficient fertilization was not achieved, grain filling ratio was decreased and yield was significantly decreased. In addition, corn seeding and hybridization studies in the same year (retention rate which was 10% in previous years decreased to 2-3%) was significantly decreased. The success of breeding studies, i.e. the retention rate, is decreased under extreme temperature and low relative humidity conditions. Therefore, breeding studies in Çukurova are carried out on the first crop with the concern of being exposed to climate-based stress in the second crop. Comparison of tables 1 and 2 indicated that particularly high temperatures and low relative humidity during the fertilization process cause significant reductions in yield. The temperature in the middle of August, which is the full fertilization period of the second crop corn in Çukurova in 2010, especially during 16-19 August, increased to 43.8˚C and the relative humidity decreased to 29.7%. Therefore, significant grain yield losses occurred. In addition, grain yield decreased in 2010 and the main reason for the decrease was attributed to the leaf blight in corn. The experts in Adana Plant Protection Research Institute stated that leaf blight disease is seen in the years when the temperature values are high, in contrast, the disease agent could not find the optimum conditions for the reproduction in normal conditions. Therefore, the decrease in corn yield can be attributed to the high temperatures and humidity seen in 2010. Considering the growth period of the first crop corn in April-August and the second crop corn in June-October, the evaluation between yield values and mean temperature and humidity values indicated the existence of linear relationships. No relationship between yield and temperature and humidity values was obtained when the first crop corn yield and 5-month mean temperature and humidity values of the growing period were taken into consideration. The results revealed that the temperature values have a higher impact on the second crop corn yield than the humidity values.

4. Effects of Precipitation on Corn Plant

The most critical months in the growing period of the corn plants are July and August which do not cause climate stress on the first crop cultivation. However, these months may show a tendency to have a detrimental influence during the whole vegetation period of the second crop corn cultivation. Because the pollination and grain filling of corn plants take place in July and August (Anonymous, 2001). Therefore, drought risk models have been developed in regions where rainfall is irregular and inadequate (Wu, 2004). The precipitation is an important factor affecting the yield and fertilization positively; however, almost no rainfall occurs in August in Çukurova. Therefore, the second crop corn plantation in Çukurova should be completed by the end of June, because delaying the planting may be risky as the vegetation period will not be sufficient. The harvesting of corn can continue from August to November depending on maturity groups, temperature, humidity and precipitation values of the region and the ability to rapidly lose moisture of the plant. No rain occurs in Çukurova during the summer months, and even if it does, the amount of precipitation is not enough to reach the effective root depth (about 5 mm). The rainfall during the pollination period contributed to the prolongation of fertilization by creating cool air.

In addition, water remaining from the winter and kept in the soil also contributes to corn growth and yield. Precipitation is an important factor in corn cultivation. Annual rainfall should be between 600 and 1200 mm for corn farming, and irrigation water is needed when rainfall is less than 600 mm. The amount of water needed by a corn plant during the growing period is higher than other cereals. Therefore, the rainfall should occur intermittently in the summer season, which is the growing period of corn, and a significant portion of the precipitation should be in the ripening period (Şahin, 2001). The vegetation period of corn is the summer months; therefore, water demand of corn plants is high due to the high temperature and evaporation during the growing period. Kaya and Yanıkoğlu (1990) stated that corn needs 500 mm of water during the vegetation period. The researchers further stated that the distribution of irrigation water should be 75 mm in May, 100 mm in June, 175 mm in July, 100 mm in August and 50 mm in September. The amount of water stated are general values and may vary from region to region.

5. Conclusion and Suggestions

The mean grain yield of the first crop corn was 1323kg da^{-1}, whereas the grain yield of the second crop was 765 kg da^{-1}. The yield recorded in the second crop was 558 kg da^{-1} less than the first crop. The results showed that the main cause of the decrease in grain yield was high temperature and undesired low relative humidity values in relation to the changes in climate. Exceeding the limit values for temperature and relative humidity had a negative effect on corn grain yield. Grain cannot be filled or the ear cannot be grown; thus, yield decrease occurs.

The tendency of cultivation areas and production values showed similarity in the period examined, in contrast, yield values decreased due to climatic conditions. Other important climate parameters affecting corn farming are temperature, precipitation and humidity. Low humidity values were observed especially during the fertilization period and low humidity caused a considerable reduction in grain yield. The increase in the average and the maximum temperatures above the threshold values in the generative growth period of corn had negative impact on the production and yield compared to the previous years. Therefore, developing the corn varieties resistant to climatic stresses during the fertilization period by means of breeding, and applying frequent irrigation and drip irrigation without waiting for 50% of the available humidity during the pollination period will be beneficial. The drip irrigation will enable the moisture in the plant root zone close to the field capacity; thus, the plant will not be exposed to moisture stress, the plant will find the desired moisture in the plant root zone at any time and this will have positive effects on pollination and yield.

APPENDIXES

APPENDIX Table 1. *Anthesis duration (days) and some morphological parameters of the first crop corn*

Name of Genotype	**Replication**	**Duration of Anthesis (day)**	**Plant Height (cm)**	**Height cob (cm)**	**In Harvest**		**Appearance**		Plot weight with the cob (g)	Harvest moisture (%)	Seed/ Cob Ratio (%)	Adjusted grain yield (kg da^{-1})
					Number of plants (piece)	Number of cobs (piece)	**Cob (1-5)**	**Plant (1-5)**				
P31G98	1	57	290	97	65	74	1	1	14850	11.8	89	1404
	2	55	285	90	66	70	1	2	16650	12	89	1566
	3	56	298	102	51	61	1	1	15530	9.7	90	1516
	4	56	298	93	61	64	1	2	13960	11.6	88	1308
ADA523	1	55	293	105	51	53	2	2	12870	11.7	89	1218
	2	54	293	110	55	58	1	1	11320	12.3	89	1063
	3	56	292	97	53	53	1	1	12080	12.7	89	1127
	4	54	280	92	70	75	1	1	12210	11.8	89	1152
DKC6589	1	53	297	97	70	75	1	2	14510	12	89	1217
	2	54	280	82	49	55	1	2	15940	8.8	89	1549
	3	53	293	93	49	56	1	1	14720	13.2	89	1365
	4	53	290	85	51	53	2	2	15780	13.2	88	1454
NKARMA	1	56	285	97	50	50	1	1	14130	13.6	88	1297
	2	55	273	83	63	62	1	2	13450	12.1	88	1254
	3	55	280	87	62	57	2	1	13300	11.6	88	1246
	4	53	267	82	60	62	1	2	14950	11.9	88	1399
MGM134757	1	53	288	95	57	61	1	1	13250	12.6	84	1168
	2	57	288	93	64	67	1	1	15640	11.8	84	1391
	3	55	292	98	64	63	1	1	13970	11.3	83	1235
	4	54	295	98	51	60	1	2	15360	12.9	89	1429
MGM147484	1	54	268	71	68	69	2	2	14450	13.6	89	1405
	2	56	283	85	49	53	1	2	15430	11	88	1386
	3	55	267	90	53	57	1	1	15810	13.1	88	1443
	4	56	285	92	56	57	1	1	13530	13.1	88	1230
MGM131830	1	54	285	88	57	55	1	2	14450	12.6	86	1304
	2	54	290	88	61	66	1	1	15430	12.5	86	1394
	3	55	287	95	68	69	1	1	15810	9.8	85	1455
	4	56	278	85	49	53	1	1	13530	12	86	1229
MGM161278	1	52	268	85	53	57	1	2	14750	11.7	84	1313
	2	53	282	95	56	57	1	2	15000	13	84	1316
	3	53	268	83	67	66	1	1	15000	11.7	85	1352
	4	53	280	83	57	55	2	2	13350	13	84	1171

APPENDIX Table 2. *Anthesis duration (days) and some morphological parameters of the second crop corn*

Name of Genotype	Replication	Duration of Anthesis (day)	Plant Height (cm)	Height cob (cm)	**Appearance**		Plot weight with the cob (g)	Harvest moisture (%)	Seed/ Cob Ratio (%)	Adjusted grain yield (kg da^{-1})
					Cob (1-5)	**Plant (1-5)**				
P3394	1	47	178	88	1	2	6200	14.8	84	746
	2	48	170	80	1	1	6280	15.3	85	760
	3	48	174	72	2	2	5360	15.7	84	638
P 32T83	1	49	180	86	1	1	7600	12.8	85	947
	2	49	175	80	1	1	7380	15.4	85	892
	3	47	170	81	1	1	8080	15.1	85	980
DK 5783	1	47	170	65	1	1	5520	15.7	83	649
	2	47	170	75	1	2	6690	15	84	803
	3	48	169	70	1	1	6580	14.3	84	796
SHEMAL	1	47	175	72	1	1	7050	13.7	85	869
	2	47	168	70	1	1	6580	13	85	818
	3	48	172	72	1	1	7820	13.4	86	979
MGM173393	1	48	175	78	1	2	6040	13.7	85	745
	2	47	167	72	2	1	5880	16.5	84	693
	3	48	170	75	1	1	5860	15	85	711
MGM144697	1	48	175	85	1	1	6060	13.9	85	745
	2	47	185	90	2	1	6010	15.1	84	720
	3	48	180	80	1	1	6770	11.8	85	853
MGM157028	1	48	175	73	2	2	7030	12.7	84	866
	2	48	171	75	2	2	4570	14.3	83	546
	3	48	172	70	3	3	4900	14	83	588
MGM116521	1	47	174	70	2	2	4890	13.5	84	597
	2	48	176	67	3	1	5630	13.4	84	689
	3	47	173	68	2	2	6040	14.7	85	736

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AN OVERVIEW ON THE RECENT PRODUCTION OF COTTON FIBRE GROWING IN ANATOLIA

CHAPTER 2

Ayşe UYGUR[1]

1 Marmara Üniversitesi- Güzel Sanatlar Fakültesi- Tekstil Bölümü

1. INTRODUCTION

Wool, linen, cotton, hemp, silk, mohair, got hair, angora rabbit hair (angora) fibres were grown in Anatolia during historical ages.

Primitive men wore animal hides before neolithic age and then they found out textile fibres such as wool, linen around 8000 B.C., and they began to spin these fibres to make yarn and then they began to weave these yarns to make cloth followed by making dresses. It is suggested that linen was possibly the first fiber discovered in the world, followed by wool (Dayıoğlu&Karakaş, 2007). It is suggested that cotton was discovered in India around 3000-3500 B.C. Archaeological excavations in Peru in the South America, around 2500 BC., pieces of woven cotton were also found. Thus, the emergence of different genetically structured old and new world cottons from different continents reveals that cotton is derived from different parts of the world (Tariş, 2019). Silk was discovered in China around 2600 B.C. Mohair was emerged in Anatolia around 1400 A.D. , angora rabbit hair was also emerged close period that of mohair. During the course of Industrial Revolution that began around 1900 A.D., an all-around developments in all fields took place including the textile industry which was seen great advancements in terms of fibre, dye, machinery, chemistry, and energy. Chardonet rayon which is the first regenerated fibre was discovered in 1885, and polyamide which is the first synthetic fibre was discovered in 1939. Discovery of the other regenerated fibres, such as viscose rayon, copper rayon, kazein etc. and synthetic fibres, such as polyamide, polyester, polyacrylonitrile etc. after natural fibres entailed gradually to decrease of the usage of natural fibres but they did not finish (Uygur&Yüksel, 2013).

It is known that human societies lived in the paleolithic age in Anatolia. Natural fibres growing in Anatolia dated old times. Çayönü, Çatalhöyük, Hacilar which are the oldest village settlements in Anatolia, people made fabric from natural fibres, linen was the first known fibre, and then beginning of clothing has been reported around 8000 B.C. (Türkoğlu, 2002). A number of woven pieces were found in the Çatalhöyük excavations, although they were charred. And additionally fine woven fabrics beside thick woven fabrics such as sacks were also found. It has been determined that these fabrics are made of wool fibres (Melart, 1967). The usage of linen to weave fabric dated around 5000 B.C., there are some determinations that it is used in Anatolia and Northern Iraq (Yağan, 1978). Hemp was seen in Anatolia in 1500 B.C. Cotton which was cultivated and evaluated in India for the first time, was reported that it entered to Anatolia through North Africa in 500-300 B.C. Silk was the most important and imported fibres as always. Linen, hemp, cotton, wool and silk were grown in Anatolia in 1300s A.D. followed by mohair and angora rabbit hair in the next centuries (Turkoglu, 2002).

Cotton varieties planted in Anatolia are Old World Cotton with closed boll since 500-300s B.C. The New World origin with open boll Upland Varieties have been introduced and cultivated in Anatolia in accordance with the international demands since 19th century, and the Ottoman Empire has taken extensive measures to improve cotton agriculture in 19th century.

Cotton farming has been the leading development in the period of the Republic of Turkey. Cotton breeding stations were established and cotton researches were started with varieties brought from USA. As a result of these researches, which have been developed and maintained until today, many cotton varieties have been obtained in accordance with the national and international market demands and ecology of the region (Tariş, 2019). Cotton is the leading fibre among the natural fibres which are grown in Anatolia and in the World.

2. COTTON PROPERTIES

Cotton is an industrial plant which is used as cotton fibre in textile industry, as vegetable oil industry with oil obtained from seed, as animal fodder from cotton boll pulp, as regenerated fibre raw material with very short fibre residues remaining in plant (Tariş, 2019).

There are four cultivated species of cotton : Gossypium arboreum, G.herbaceum, G.hirsutum and G.barbadense. The first two species are diploid (2n=26) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid (2n=52) and are new world cotton. G. Barbadense is Egyptian cotton. G.hirsutum is American cotton and is the predominant species which alone contributes about 90% to the global production (Singh & Kairon, 1997). Cotton grown species in Turkey is Gossypium hirsutum.

Cotton varieties which are grown in Turkey are mainly Coker 100 A/2, Deltapine 15/21, Coker 100/153, Caroline Queen 201, Sealand, indigenous cotton (cotton with close boll) (Maydos yerlisi, Kırmızı yerli) (Clevland, Akala varieties till 1960s) (Harmancıoğlu, 1979); Beren, Adana 98, ADN-P01, Acala 130, DPL 15/21, Carolina Queen, Adana 967 10 , Sayar 314, Çukurova 1518, Gelincik, Sarı Gelin, ADN 123, ADN 811, ADN 413, ADN 710, ADN 712, NİHAL (Tarım Orman, 2019); Nazilli 84: Nazilli 87, Nazilli M-503, Nazilli 143-F (Tariş, 2019); Lodos (İYTE, 2018); Nazilli M-39, Stonville-453, SG 125, SG 404, SG 501, SG 1001, DP 20, DP 50, DP 5409, DP 5614, DP 5690, Deltaopal , Nata, Lachata, Nazilli 342, Rex, Carolina Queen 201/1971, Çukurova 1518, DPL 50, DPL 5690, Erşan 92 (Tekstil Bilgi, 2019). Cotton boll and cotton field are given in Figures 1,2,3.

Figure 1,2. *Cotton boll*

Figure 3. *Cotton field*

Cotton is an annual plant. Seeds sown in spring bloom in pink - red after 80-100 days and the seed boll emerges when these flowers are poured. This boll contains about 4-20 seeds. The ripening of the cotton boll lasts 45-50 days and eventually cracks and yields cotton seeds coated with fibres. There are 10000-20000 fibres on cotton seed. Cotton fibres are harvested from August to October. Cotton collected by hand or machinery from the field is called cotton unseed. Cotton unseed is sent to gin machines to separate cotton fibres from cotton boll cover residues and seeds. Ginned cotton fibres called as cotton lint is turned into bales and sent to spinning mills (Başer, 1992).

Cotton is grown in subtropical regions of all continents in the world , lying roughly between the parallels of latitude of 35^0 North and South of the Equator (Miller, 1992). Sea Island and America Upland Cotton likes this warm and humid climate. Indian cotton needs above 10 ^{0}C in winter and under 25 ^{0}C in summer (Dayıoğlu, Karakaş, 2007) .

Cotton is usually creamy white in colour, cheapest, soft, the length of the fibre can be 1,0-5,5 cm, and its fineness varies between 6-25 microns. It absorbs 8-10 % moisture. It has no thermal insulation. Durability of cotton increases when it is wet. Sunlight damages cotton. The average amount of elongation is 7-8%, it is not elastic.

Cotton fibres are divided into 3 group according to the fibre length:

Fibre length: 2,5- 6,5 cm: Thin shiny fibres.

Fibre length 1,5- 3,0 cm: Medium durability and medium gloss.

Fibre length 1-2,5 cm: Coarse and low value (Başer, 1992).

3. RECENT PRODUCTION OF COTTON FIBER IN ANATOLIA

Cotton are mainly grown in Aegean Region of Anatolia, Adana- Çukurova Region and Southeast Anatolian Region in Turkey. It is seen that cotton fibres are mainly grown in Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır, İzmir, Mardin, Gaziantep, Denizli, Adıyaman and additionally Antalya, Balıkesir, Batman, Iğdır, Kahramanmaraş, Kilis, Manisa, Mersin, Muğla, Osmaniye, Siirt, Canakkale, Şırnak cities in Anatolia. There are changes in their cotton production depending on the years. Production tables and graphs of cotton unseed and cotton lint in leading 10 (5+5) cities of Turkey between 2009-2018 are given below successively.

Production tables and graphs of cotton unseed in first leading 5 cities of Turkey between 2009-2018 are given in Table 1 as numerically and in Figure 4 as graphically (TÜİK, 2019).

Table 1. *Cotton unseed production of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır and Turkey total between 2009-2018 (ton).*

Year	Cotton Unseed Production	(ton)				Turkey total (ton)
	Şanlıurfa	Aydın	Adana	Hatay	Diyarbakır	
2009	668951	188678	275480	135594	108149	1725000
2010	862256	223563	248950	231390	154995	2150000
2011	970771	243669	308560	269918	195413	2580000
2012	953246	250997	239091	210248	175091	2320000
2013	948464	287031	212035	202791	197835	2250000
2014	1022213	316856	204467	196766	191729	2350000
2015	916298	287473	138612	209458	141289	2050000
2016	852391	326475	151880	242357	169215	2100000
2017	1028315	331161	168287	265682	217221	2450000
2018	1027625	279377	206143	263901	244497	2570000

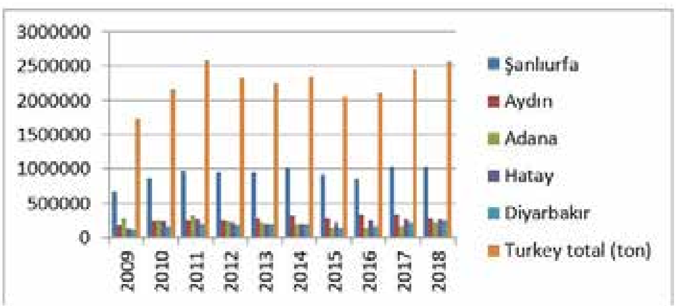

Figure 4. *Cotton unseed production of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır and Turkey total between 2009-2018 (ton).*

Production tables and graphs of cotton unseed in first leading 5 cities of Turkey between 2004-2008 are given in Table 2 as numerically and in Figure 5 as graphically (TÜİK, 2019).

Table 2. *Cotton unseed production of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır and Turkey total between 2004-2008 (ton) .*

Year	Cotton Unseed Production	(ton)				Turkey total (ton)
	Şanlıurfa	Aydın	Adana	Hatay	Diyarbakır	
2004	736625	243889	159750	268812	261835	2455 071
2005	734532	190123	163312	283655	232460	2240 000
2006	835011	226860	291582	290389	222176	2550 000
2007	821896	198948	243431	279717	217289	2275 000
2008	799014	144908	224099	138921	162906	1820 000

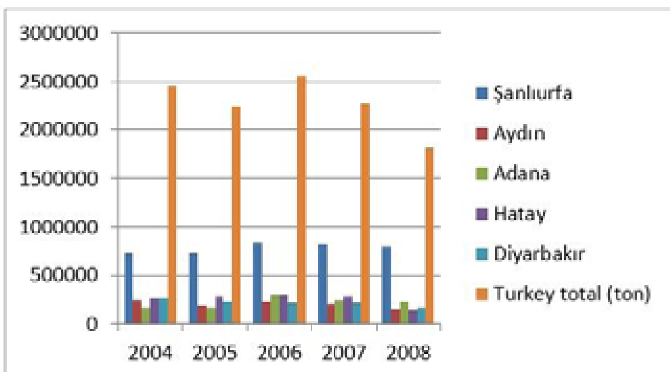

Figure 5 . *Cotton unseed production of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır and Turkey total between 2008-2004 (ton) .*

Production tables and graphs of cotton lint in leading first 5 cities of Turkey between 2009-2018 are given in Table 3 as numerically and in Figure 6 as graphically (TÜİK, 2019).

Table 3. *Cotton lint production of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır and Turkey total between 2009-2018 (ton).*

Year	Cotton lint Production (ton)					Turkey total (ton)
	Şanlıurfa	Aydın	Adana	Hatay	Diyarbakır	
2009	247512	69811	101927	50171	40015	638250
2010	327830	84947	94373	87440	59010	816705
2011	359181	90157	114168	99866	72303	954600
2012	352688	92868	88465	77793	64784	858400
2013	369689	111990	82706	79182	77097	877500
2014	367995	114071	73608	70835	69022	846000
2015	329867	103491	49901	75406	50866	738000
2016	306859	117532	54680	87248	60917	756000
2017	370203	119216	60583	95645	78200	882000
2018	390496	106165	78335	100283	92909	976600

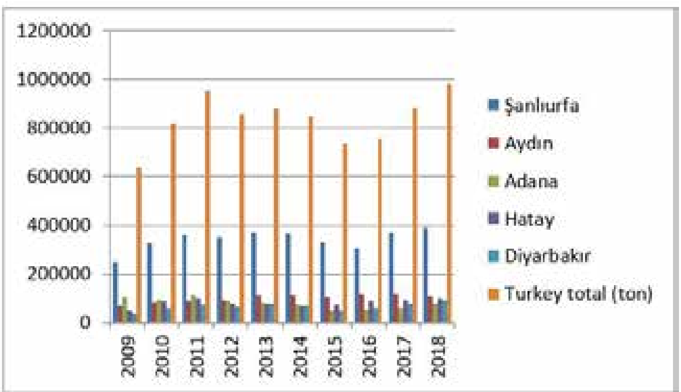

Figure 6 : *Cotton lint production of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır and Turkey total between 2009-2018 (ton).*

Production tables and graphs of cotton unseed in second leading 5 cities of Turkey between 2009-2018 are given in Table 4 as numerically and in Figure 7 as graphically (TÜİK, 2019).

Table 4. *Cotton unseed production of İzmir, Mardin, Gaziantep, Denizli, Adıyaman and Turkey total between 2009-2018 (ton) .*

Year	Cotton Unseed Production	(ton)				Toplam Türkiye (ton)
	İzmir	Mardin	Gaziantep	Denizli	Adıyaman	
2009	95415	93101	5942	12858	53933	1725000
2010	116596	81914	39724	19001	49167	2150000
2011	144244	118186	57562	29168	75040	2580000
2012	111261	116042	45590	26948	66851	2320000
2013	118325	57157	32769	27241	47948	2250000
2014	133700	55203	40162	36020	35242	2350000
2015	120505	41319	32368	31817	34872	2050000
2016	118793	43265	29161	38206	29461	2100000
2017	143641	41847	29292	47471	32052	2450000
2018	156077	56916	38525	42517	40635	2570000

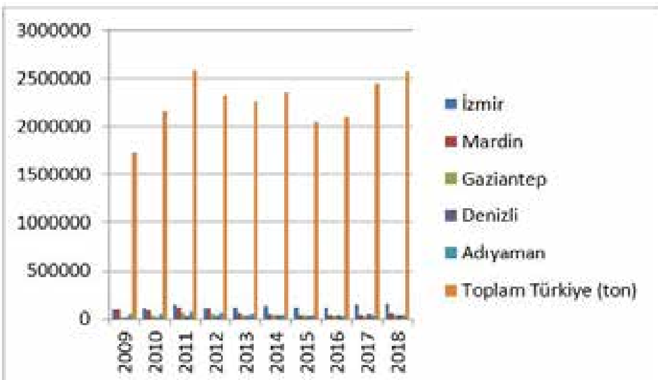

Figure 7: *Cotton unseed production of İzmir, Mardin, Gaziantep, Denizli, Adıyaman and Turkey total between 2009-2018 (ton).*

Production tables and graphs of cotton unseed in second leading 5 cities of Turkey between 2004-2008 are given in Table 5 as numerically and in Figure 8 as graphically (TÜİK, 2019).

Table 5. *Cotton unseed production of İzmir, Mardin, Gaziantep, Denizli, Adıyaman and Turkey total between 2004-2008 (ton).*

Year	Cotton Unseed Production	(ton)				Turkey total (ton)
	İzmir	Mardin	Gaziantep	Denizli	Adıyaman	
2004	186583	65000	59600	54356	60585	2455071
2005	156907	47207	61300	44289	58342	2240000
2006	159614	96362	66442	49124	60146	2550000
2007	126673	58086	59996	29947	57606	2275000
2008	76694	84127	21070	18121	47955	1820000

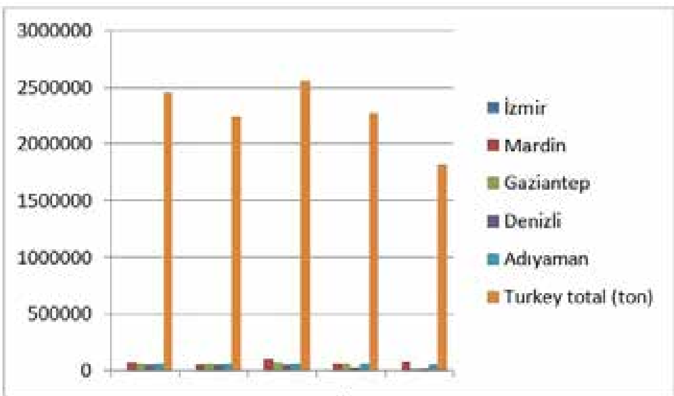

Figure 8. *Cotton unseed production of İzmir, Mardin, Gaziantep, Denizli, Adıyaman and Turkey total between 2004-2008 (ton).*

Production tables and graphs of cotton lint in second leading 5 cities of Turkey between 2009-2018 are given in Table 6 as numerically and in Figure 9 as graphically (TÜİK, 2019).

Table 6. *Cotton lint production of İzmir, Mardin, Gaziantep, Denizli, Adıyaman and Turkey total between 2009-2018 (ton).*

Year	Cotton lint Production (ton)					Toplam Türkiye (ton)
	İzmir	Mardin	Gaziantep	Denizli	Adıyaman	
2009	35306	34447	2199	4756	19955	638250
2010	44393	31055	15125	7226	18708	816705
2011	53370	43728	21300	10792	27765	954600
2012	41169	42937	16869	9972	24737	858400
2013	46183	22319	12802	10610	18716	877500
2014	48134	19873	14457	12966	12688	846000
2015	43382	14875	11652	11454	12553	738000
2016	42767	15576	10498	13755	10605	756000
2017	51708	15064	10545	17089	11537	882000
2018	59310	21628	14640	16157	15441	976600

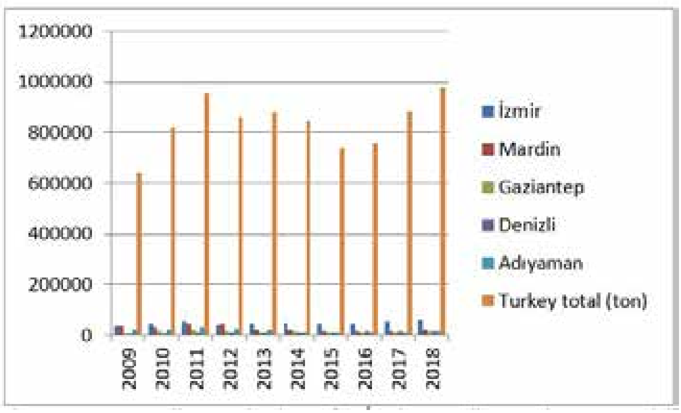

Figure 9. *Cotton lint production of İzmir, Mardin, Gaziantep, Denizli, Adıyaman and Turkey total between 2009-2018 (ton) .*

Anatolia was known cotton production centre in 1980s, Aegean and Adana- Çukurova- Antalya regions were leading production regions. But GAP Project (Southeastern Anatolia Project) which covers 9 cities (Adiyaman, Batman, Diyarbakir, Gaziantep, Kilis, Mardin, Siirt, Sanliurfa, Sirnak) in the upper Mesopotamian plains began to irrigate these cities and cotton production regions began to change toward GAP cities. GAP project is going on, it is estimated that the ratio will also increase at the end of GAP Project (GAP, 2019). Cotton unseed production ratios of 10 leading cities in Turkey in 2018 and 2004 are given below in Table 7 (TÜİK, 2019).

Table 7. *Cotton unseed and cotton lint production ratios of Şanlıurfa, Aydın, Adana, Hatay, Diyarbakır, İzmir, Mardin, Gaziantep, Denizli, Adıyaman in Turkey in 2018 and 2004, beside cotton unseed production change % of these leading cities between 2004-2018.*

City	Cotton unseed % in 2018	Cotton lint % in 2018	Cotton unseed % in 2004	Cotton unseed change % 2004-2018
Şanlıurfa	40,0	40,0	30,0	+10,0
Aydın	10,9	10,9	9,9	+1,0
Adana	8,0	8,0	6,5	+1,5
Hatay	10,3	10,3	11,0	-0,7
Diyarbakır	9,5	9,5	10,7	-1,2
İzmir	6,1	6,1	7,6	-1,5
Mardin	2,2	2,2	2,7	-0,5
Gaziantep	1,5	1,5	2,4	-0,9
Denizli	1,7	1,7	2,2	-0,5
Adıyaman	1,6	1,6	2,5	-0,9
Total	91,8	91,8	85,5	

It is seen that;

Cotton unseed and cotton lint ratios are the same in Table 7 that the gin process didn’t change the ratio of cotton fibres in a city.

Turkey total cotton production increased only 4,7% while textile industry production increased much more than this ratio within 2004-2018 period.

Şanlıurfa meets alone 40% of cotton production of Turkey in 2018.

While the rate of unseed cotton of Şanlıurfa in Turkey's total production in the GAP region was 30% in 2004, it increased to 40% in 2018. While this great increase change ratio of 10% in Şanlıurfa between 2004-2018 period, other GAP cities such as Diyarbakır, Gaziantep, Adıyaman, Mardin exhibits a little decrease change ratio which were given successively: 1, 2 % ; 0.9% ; 0.9% ; 0.5% .

Only Aydın and Adana cities showed a little increase change ratio as 1% and 1,5 % successively while İzmir, Denizli showed a little decrease change ratio as 1,5 %, 0,5 % successively.

4. ORGANIC COTTON

Cotton which doesn't use pesticide, chemical fertilizer, GMO seeds when growing and is produced in accordance with certificate is organic cotton. Conventionally cotton in the world uses % 25 of pesticide (16% of all the insecticides and 6,8% of all herbicides used) (Tarakçıoğlu, 2008) and cotton is in the 4th place in the use of chemical fertilizers in the world, and needs 33% fertilizer of raw cotton weight during cultivation (Organik Tekstil, 2019).

India (66,9%), China (11,7%), Turkey (6,5%), Kyrgyzstan (4,9), USA (2,2) are the main organic cotton producers in the world successively in 2016 (Kalkanci, 2017).

The cotton grown in the world includes only 1% of organic cotton, this rate is 2.4% in Turkey in 2012 (Gür, 2014). The ratio of organic cotton grown in Turkey is lower than that of conventional cotton and organic cotton production is issued under conventional cotton productions between the 2009- 2018 years.

5. COTTON PRODUCTION, EXPORT, IMPORT OF TURKEY BETWEEN 2009-2018

The amount of cotton production, export, import in Turkey between 2009-2018 period are given in Table 8 as numerically and in Figure 10 as graphically (TÜİK, 2019).

Table 8. *The amount of cotton production, export, import in Turkey between 2009-2018 (kg).*

Year	Cotton Unseed Production (kg)	Cotton Lint Production (kg)	Cotton Export (kg)	Cotton Import (kg)
2009	1.725.000.000	638.250.000	223.401.137	936.912.217
2010	2.150.000.000	816.705.000	210.623.955	1.158.664.688
2011	2.580.000.000	954.600.000	236.673.186	811.135.029
2012	2.320.000.000	858.400.000	266.856.834	780.515.909
2013	2.250.000.000	877.500.000	267.111.542	1.080.902.736
2014	2.350.000.000	846.000.000	268.339.949	1.136.617.294
2015	2.050.000.000	738.000.000	296.833.566	1.004.066.173
2016	2.100.000.000	756.000.000	296.833.566	1.004.066.173
2017	2.450.000.000	882.000.000	312.523.569	1.213.800.923
2018	2.570.000.000	976.600.000	380.232.412	1.000.124.434

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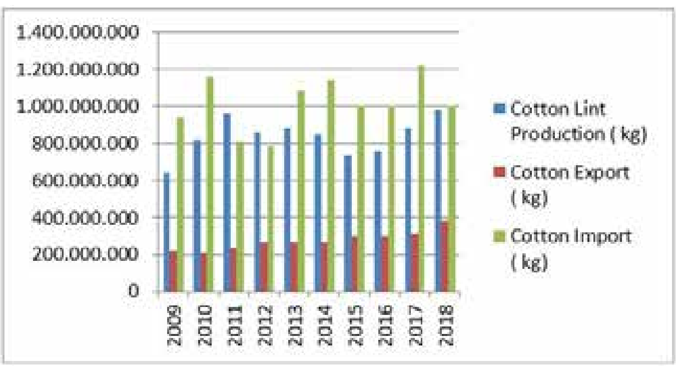

Figure 10 . *The amount of cotton production, export, import in Turkey between 2009-2018 (kg).*

It is seen that ;

Cotton production of Turkey does not meet cotton demand for industrial production, so cotton is imported.

Cotton production meets 49,4 % of the sum of cotton production plus cotton import whereas cotton import meets 50,6 % of the sum of cotton production plus cotton import; therefore it is seen that cotton production doesn't meet cotton requirement and cotton import meets nearly half amount of cotton in 2018.

There is also 19,2% of export of the sum of cotton production plus cotton import.

The agricultural areas of cotton in Turkey are given in Table 9 as numerically and as graphically in Figure 11. The acreage of Turkey is 783 562 000 decares. The agricultural area of cotton corresponds to 0,66 % of total Turkey acreage and 2,24 % of total agricultural area of Turkey in 2018 (TÜİK, 2019).

Table 9 . *The agricultural area of cotton in Turkey (decare=1000 m^2)*

Year	2009	2010	2011	2012	2013	Turkey
Agricultural area (decare)	4200000	4806500	5420000	4884963	4508900	783562000
Year	2014	2015	2016	2017	2018	Turkey
Agricultural area (decare)	4681429	4340134	4160098	5018534	5186342	783562000

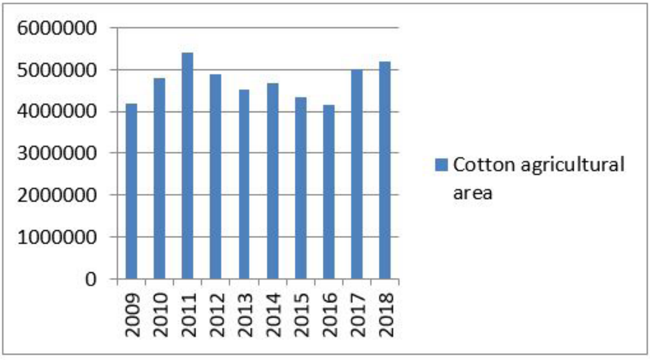

Figure 11 .*The agricultural area of cotton in Turkey (decare=1000 m^2)*

World Cotton Production

World Cotton Production between 2014-2018 period is given in Table 10 (Ticaret Bakanlığı , 2019).

Table 10 .*Cotton lint production of the world between 2014-2018 (ton)*

	Country	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
1	China	6600000	5200000	4900000	5890000	5940000
2	India	6562000	5746000	5865000	6350000	5920000
3	US	3553000	2826000	3738000	4560000	4050000
4	Brasil	1563000	1289000	1530000	2010000	2410000
5	Pakistan	2305000	1537000	1663000	1800000	1690000
6	Turkey	724000	640000	703000	792000	988000
7	Uzbekistan	885000	832000	789000	800000	640000
8	Australia	528000	470000	891000	1044000	580000
9	Mexico	302000	188000	164000	335000	320000
10	Turkmenistan	330000	300000	296000	304000	300000
	Other	2883000	2448000	2536000	2835000	3082000
	Total	26235000	21476000	23075000	26720000	25920000

It is seen that;

China, India, US, Brasil, Pakistan, Turkey, Uzbekistan, Australia, Mexico, Turkmenistan are mainly cotton producer countries in the world successively. Turkey is the sixth in the world cotton production. Turkey meets 3% of total cotton production of the world.

6. CONCLUSIONS

Cotton fibres have been grown in Anatolia for 2300-2500 years. Cotton is the most produced and the most widely used fibre in the Anatolia. Whereas domestic cotton production met the whole Turkey textile demand of industry in 1980s; abolishment of quotas in recent years, less a reasonable cost level for their ability to provide imported cotton to meet the process was initiated. It is observed that, much more amount of cotton was imported than that of domestic produced cotton during recent years. Since the production of cotton varies according to the years and demands of textile production, it is outlined the production, export, import of cotton grown in Anatolia for ten yearly period between 2009-2018.

It is concluded that;

Cotton unseed and cotton lint ratios are the same that it exposes the yield of gin process is also the same.

Turkey total cotton production increased only 4,7% while textile industry developed within 2004-2018 period.

Şanlıurfa meets alone 40% of cotton production of Turkey in 2018.

Whereas the rate of unseed cotton of Şanlıurfa in Turkey's total production was 30% in 2004, it increased to 40% in 2018. While this great increase change ratio of 10% in Şanlıurfa between 2004-2018 period, other GAP cities such as Diyarbakir, Gaziantep, Adıyaman, Mardin exhibited a little decrease change ratio which were given successively: 1, 2 % ; 0.9% ; 0.9% ; 0.5% .

Only Aydın and Adana cities showed a little increase change ratio as 1% and 1,5 % successively while İzmir, Denizli showed a little decrease change ratio as 1,5 %, 0,5 % successively.

The rate of organic cotton grown in Turkey is 2.4% in 2012 and organic cotton is given together with conventional cotton.

Cotton production of Turkey does not meet cotton demand for industrial production, so cotton is imported.

Cotton production meets 49,4 % of the sum of cotton production plus cotton import; and cotton import meets 50,6 % of the sum of cotton production plus cotton import; therefore it is seen that cotton production doesn't meet cotton requirement and cotton import meets nearly half amount of cotton in 2018.

There is also 19,2% of export of the sum of cotton production plus cotton import.

China, India, US, Brazil, Pakistan, Turkey, Uzbekistan, Australia, Mexico, Turkmenistan are mainly cotton producer countries in the world successively.

Turkey is the sixth in the world cotton production. Turkey meet 3% of total world cotton production.

Textile fibres are the main sources of textile and natural fibres are our natural wealth. Ministry of Agriculture and Forestry, Ministry of Industry and Technology, Ministry of Commerce, Ministry of Commerce, Textile Industry Components, and so on, should supply the necessary conditions to grow cotton in Anatolia to meet total industrial demand and should address these issues importantly.

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POULTRY BIODIVERSITY AND UNREGISTERED NATIVE CHICKEN BREEDS OF TURKEY

CHAPTER 3

Demir ÖZDEMİR[1]

[1] Assit. Prof. PhD. Akdeniz University, Faculty of Agriculture, Department of Agricultural Biotechnology, dozdemir@akdeniz.edu.tr

INTRODUCTION

The chicken breeds that exist today are thought to derive from the varieties of wild type Red Jungle Fowl (red, grey, Java and Ceylon fowl), which are first domesticated at Indochina region in 8000-10000 B.C. (Larson and Fuller, 2014; Xiang et al, 2014). Chickens are not capable of flying long distances and they are not anatomically suitable for swimming, so the migration of chickens among continents has been through humans (Storey, 2012). The spread of chickens by humans dates back to the Persian Empire, which ruled in the 4 B.C. It is stated that when the Persians conquered India, they were influenced by domestic chickens and became interested in poultry due to food supply and demonstration (cockfighting). In later periods, Persians introduced the chicken to Greece and Egypt, while Greece introduced it to the Romans (Smith and Daniel, 1982; Lacey, 2000). In the process of spreading the chicken from Asia to Europe and Africa by the Persians, Anatolia assumed a very strategic role due to its geographical location where has been home to many civilizations throughout history. Anatolia, which has been home to many civilizations other than the Persian Empire throughout its history, is also one of the first centers where some farm animals were domesticated. Despite all this historical and cultural richness, which has an effect on biodiversity, only 2 local chicken breeds (Denizli and Gerze) are officially registered in Turkey today.

Denizli chicken breed is locally reared in Denizli city and its prefectures in the western part of Turkey. Although Denizli chicken is a combined breed with its egg and meat production, its cockerels are famous with their long crowing feature (20-25s). This characteristic of the breed has attracted interest from hobby chicken breeders and caused the breed to spread throughout the country. Gerze chicken breed is the other registered Turkish native chicken breed that is located only in Gerze, a town and a district of Sinop Province in the Black

Sea region of Turkey. Gerze breed is also combined chicken breed but doesn't' have an attractive feature for the breeders and so today, Gerze breed is under risk of extinction. Recently, to safeguard the future of the breeds, Denizli and Gerze chicken breeds are under conservation by the Turkish Ministry of Agriculture and Forestry. Considering the history of Anatolia and its role in spreading chickens from the domestication center to other continents, it is interesting that only two breeds of chickens have been registered to date. However, chicken breeds that have been bred by the public since ancient times but have not been officially registered until now still exist in Anatolia. In this chapter, Turkish chicken breeds that have not yet been registered but have a very old raising history in Anatolia are mentioned.

Sultan (Serai) Breed

The Sultan chicken, one of the chicken breeds known for many years in Anatolia, was raised for exhibition purposes in "kuşluk", a special poultry coop areas, in the serai gardens during the Ottoman Empire (Zeki, 1931; Çakılcı 2018). It is reported in foreign literature that the Sultan's chicken originated from Turkey and was brought from Anatolia to other countries dating back to the late 1800s (Tegetmeier, 1867). Although it has a very old history, the Sultan chicken breed attracts the attention of ornamental chicken breeders today due to its decorative feather structure and it is raised extensively in cities such as Istanbul, Kocaeli, Sakarya, Yalova, Bolu, Düzce, Bilecik, Bursa and Kütahya (Figure 1). The most notable feature of the Sultan chicken breed is the oval and long feathers on the head, which is called the crest on both sexes. Sultan chickens' crests resemble "kavuk"; a special hat used by the Sultans and that is why the breed was named Sultan. Inheritance of the crest characteristics is incomplete autosomal dominant, which means that homozygous but also heterozygous animals show a crest. The crest feathers on the skull differ in shape in Sultan chickens and roosters. The apex feathers of the males are longer than those of the females and appear to be tilted towards the back of the skull, while the apex feathers of the females have a dense appearance that almost closes the eyes. Another specific characteristic of the Sultan fowl is the comb type. Similar to the Gerze chicken breed, Sultan breed has a "v-shaped" comb type, which is controlled by three allele genes (Dorshorst et al., 2015). One of the most distinctive features that distinguish the Sultan breed from other chicken breeds is the difference in foot structure. Normally, chickens have four toes on each foot, while the Sultan chicken breed has five toes on each foot according to a mutant Po gene that causes extra digit (polydactyly) formation on chicken foot (Huang 2006; Corti et al., 2010; Sun et al., 2014). Moreover, the ankle of Sultans covered by full of feathers that is not a feature that appears in chickens in the wild form.

The males and females of the sultan breed, which have a very delicate structure, reach 2 and 1.5 kg live weight at age of sexual maturity, respectively (Ertuğrul, 2006). Depending on care and feeding, Sultans can lay 60-90 eggs per year. Sultan chickens, which have low yield and light live weight, take their place among the rare ornamental chickens of Turkey due to their cultural heritage and decorative feather structure (Figure 2).

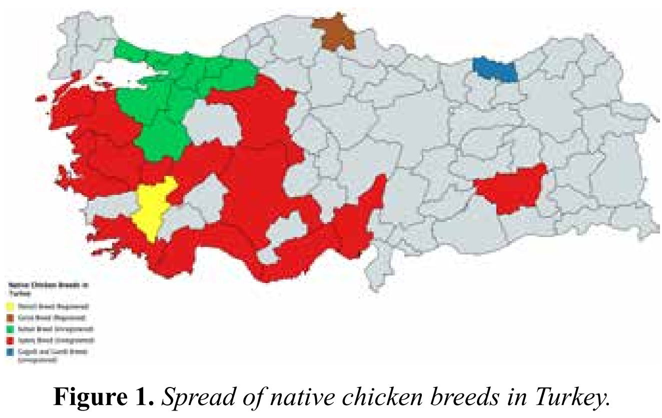

Figure 1. *Spread of native chicken breeds in Turkey.*

İspenç Breed

İspenç chicken breed is the other unregistered native chicken breed of Turkey. This miniature breed takes its name from a kind of agricultural tax that was taken from non-Muslims during the Ottoman Empire (İnalcık, 1959). Although there is no concrete information about the history of İspenç breed in Turkey, as many Turkish chicken breeds, figures of İspenç chickens were found in the floor mosaics of the Dağ Pazar Church, which was built in the fifth century A.D. in Mersin (Yılmaz, 2012).

İspenç has a wide spread through the Anatolia and is very famous among the ornamental chicken breeders according to its low feed consumption (60-65 g/per day), high yield egg production (160-180 eggs/per year) with 30-35 g egg weight and multicolored variations (Figure 1). İspenç chicken breed has a lot of color variations, but most common feather colors are buff mottled, brown mottled, buff, black mottled and blue.

Figure 2. *Native chicken breeds of Turkey.*

Similar to the Sultan chicken breed, the influence of the autosomal dominant Po (polydactyly) gene is also seen in İspenç breed. The effect of this gene is followed by the formation of five toes on each foot in İspenç. In highly inbred populations, sixth toe formation can be observed in some İspenç individuals and this can be resulted in embryonic mortality during hatchery. İspenç breed is also similar to the Sultan breed in terms of feathered ankles (ptilopody). Ptilopody in chickens is controlling by Pti-1 and Pti-2 genes as well as in İspençs and Sultans (Somes, 1992)

Having an upright body posture, the İspenç breed has rose comb with high papillae and has beard and muff feathers in both sexes (Figure 2). At sexual maturity, the average live weight of hens and roosters is 0.582 kg and 0.733 kg respectively. The İspenç breed, which has a fairly small body formation, is included in the full bantam breed category. The body length and the open wing length of İspenç breed are reported as 42 cm and 50 cm respectively (Özdemir, 2019). Like the Sultan breed, registration attempts have been initiated for the İspenç breed and it is expected that the ministry will register these two chicken breeds in the near future.

Gugulli Breed

Gugulli is a crested local chicken breed, which located in Trabzon province in the Northern part of Turkey (Figure 1). The history of the breed depends on 100-150 years ago. Gugul means crest in folk language in Trabzon, so Gugulli means “crested” chicken. The crest structure varies between sexes; Gugulli roosters have a messy crest feathers while chickens have more condense crest feathers, but in both sexes breed has a folded single comb. The Gugulli breed, which at first glance is noted for its crest feathers, has an upright body posture and a strong skeleton structure (Figure 2). Moreover, in both sexes, wide hip structure is the other salient characteristics of the breed. Therefore, Gugulli breed, with its posture, boned body type and morphological features, bears a resemblance to the *Gallina*

Turcica, which attracted considerable attention in Europe in the 1600s (Aldrovandi, 1599). At sexual maturity, the average live weight of the Gugulli hens and roosters is 2-2.25 kg and 3-3.5 kg respectively. With a large chest and breast structure, breed also has delicious meat. Genetically, Gugulli chickens do not exhibit broodiness behavior; therefore the local breeders prefer Gugulli chickens for egg production also. The average egg weight in Gugulli chickens, which can reach an annual yield of 200 eggs, is around 70 g and eggshell colour varies from creamy to light brown. Due to its combined production type and high adaptability to poor environmental conditions, breeders in the Black Sea region prefer Gugulli breed.

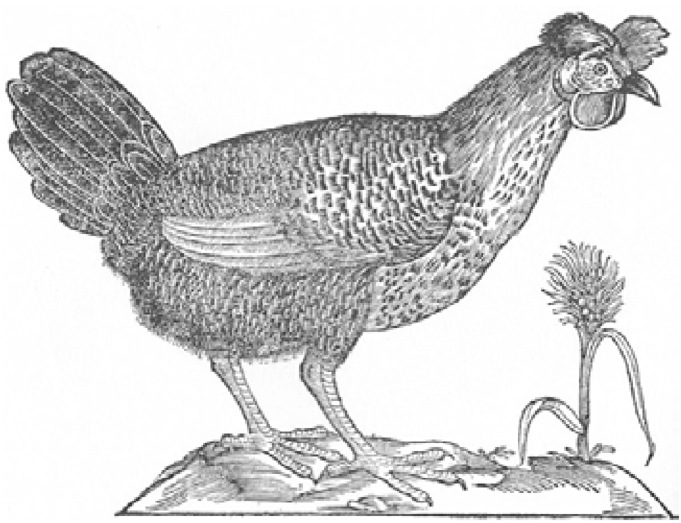

Figure 3. *Gallina Turcica, picture by Ullise Aldrovandi in 1600.*

In Gugulli breed, the legs are thick and short in direct proportion to the thickness of the skeletal structure and the shank colour is mostly yellow, although individuals with black and grey shank colours have been observed in the population. The Gugulli chicken breed, which has been raised only locally around the province of Trabzon until now, has the appearance of a suitable breed to be developed due to its meat and egg yield direction.

Gundi Breed

Gundi is an ancient chicken breed of Turkey, which is raised with a very limited population size in the towns of Trabzon (Figure 1). The word Gundi, meaning "peasant", is said to come from the period of the Greek Empire and in Black Sea region Gundi breed is also called the village chicken. The most important feature of the Gundi chicken breed is the lack of tail vertebrae (Figure 2). This phenotype is called "Rumpless" and characterized by the absence of all free caudal vertebrae and the uropygial gland (Dunn, 1934; Noorai, 2012). A dominant "Rp" gene controls the rumpless phenotype and homozygous form of this genetic characteristic can be lethal in embryonic stage in highly inbred populations. Moreover, it is reported that rumpless birds also have reduced fecundity in adults (Dunn, 1934). The number of Gundi populations in Table 1 also supports the negative effects of the Rp gene on reproduction.

Rose comb and pea comb types can be seen in the Gundi chicken phenotype. There is no exact information about the genetic admix ratio of the Gundi populations, but variation in the comb type indicates that the breed has experienced genetic mixture in the past. Unfortunately there is no study on the meat and egg performance of Gundi breed, however, as a result of negotiations with breeders, it has been reported that the breed is resistant to poor environmental conditions and has a satisfactory egg production.

Safeguarding poultry biodiversity is a key objective in every developed country; however, in recent years to maximize the yields, intensive poultry has concentrated on a few synthetic breeds and this caused genetic loss of local poultry species in developing countries such like Turkey. In Table 1 the population size of different native chicken breeds of Turkey is given. The results given in the chart are provided from the survey results that conducted with hobby and ornamental chicken breeders (n=1094). According to Table 1, Gerze and Gundi breeds are considered to be at risk of extinction. With priority, the Turkish Ministry of Agriculture and Forestry must prepare an action plan for the identification and conservation of Gerze and Gundi breeds immediately.

Table 1. *Population size of native chicken breeds in Turkey.*

NATIVE CHICKEN BREEDS OF TURKEY	Number of Roosters	Number of Chickens	Number of Chicks
Denizli*	200320	1001873	2003430
Gerze*	226	449	665
Sultan	642	1258	3541
İspenç	1083	2585	5752
Gugulli	219	501	840
Gundi	156	562	793

* **Officially registered native chicken breeds.**

CONCLUSION

Anatolia is considered as one of the world's most important biodiversity centers because it is one of the first established agricultural and domestication centers, many trade routes pass through its territory and has appropriate climatic conditions. However, having a long-established history and a strategic geographic position, poultry biodiversity in Anatolia today has unfortunately declined considerably with the acceleration of commercial poultry farming. In addition, there is unfortunately not enough information about the current poultry species and breeds in Turkey. Despite all these negativity, the existence of chicken breeds in different parts of Turkey, which are conserved and bred by the respective breeders, is very promising. This chapter has aimed to contribute to identify unregistered local chicken breeds and to draw attention to the poultry biodiversity of Turkey. However, considering the history and strategic position of our country, it is obvious that there are many other breeds and poultry species on this land besides the chicken breeds mentioned in this chapter.

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CHAPTER 4

FRESHWATER MICROALGAE (SCHIZOCHYTRIUM SP.) AS AN OMEGA-3 FATTY ACID SOURCE

Deniz ŞAHİN[1]

[1] PhD Istanbul Technical University, Department of Molecular Biology and Genetics

Long Chain Polyunsaturated Fatty Acids

Long chain polyunsaturated fatty acids (PUFAs) are fatty acids which contain more than one double bond in their backbone structure. Some of the PUFAs are called essential fatty acids which are required for biological processes and cannot be synthesized by humans or other animals. For animals, essential fatty acids must be taken through their diet. Like all fatty acids, PUFAs consist of long carbon chains containing carboxyl group at one end and methyl group at the other end [San Giovanni *et al.*, 2005; Tapiero *et al.*, 2002].

Omega-3 Fatty Acids

Omega-3 and omega-6 fatty acids are two major classes of long chain polyunsaturated fatty acids. They are both essential fatty acids and the only difference in structure between them is that last double bond is six carbons from the omega end of the fatty acid molecule in omega-6 fatty acids.

Docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) and alpha-linolenic (ALA) are some of the important types of omega-3 fatty acids (Figure 1). EPA has 20 carbon atoms and 5 double bonds (20:5 n-3). DHA, with its 22 carbon atoms and 2 double bonds (22:6 n-3), is the longest and unsaturated fatty acid among the fatty acids commonly found in biological systems. ALA has 18 carbon and 3 double bonds (18:3 n-3). Especially, DHA and EPA are very important for human consumption because of their positive effects on human health and their role in the prevention of many human diseases [Connor, 2000; Simopoulos, 2002]. ALA can be converted to EPA and DHA in the body by elongase and saturase enzymes but the process is not efficient and only a small amount of DHA and EPA can be produced [San Giovanni *et al.*, 2005]. Overall, they must be obtained from the diet [Ji *et al.,* 2015].

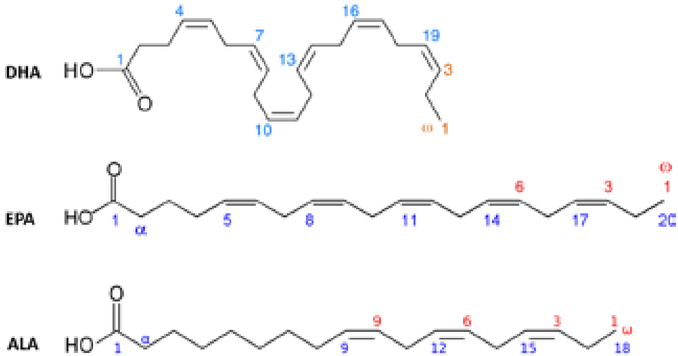

Figure 1: *Structures of Docosahexaenoic acid, DHA (22:6 n-3); Eicosapentaenoic acid, EPA (20:5 n-3) and α-Linolenic acid (18:3 n-3). [URL1]*

Importance of DHA and EPA

Omega-3 fatty acids, particularly DHA and EPA, are important for human development and health among all LC-PUFAs. DHA has been shown to contribute various metabolisms such as enhancement of human brain in the course of evolution, development of normal composition of sperm retina and brain lipids [Crawford *et al.,* 1999].

Tapiero *et al.* [2002] demonstrated that abnormalities would happen in brain function in the absence of DHA. The interaction between DHA intake and Alzheimer disease was also reported by several studies. Lim *et al.* [2005] reported that high levels of DHA intake prevents β-amyloid production thereby lower the risk of occurrence of Alzheimer disease. Omega-3 fatty acids are also important to maintain the healthy state of immune system, cardiovascular system and nervous system [Mehta *et al.,* 1988; Simopoulos, 2002].

Besides their positive effects on mental development, blood pressure and coagulation and immune system, omega-3 fatty acids were also reported to have an effect on cancer cells by inhibiting proliferation and promoting apoptosis. DHA and EPA were showed to induce apoptosis by itself or in combination with other chemotherapy agents [Berquin *et al.,* 2008; Siddiqui *et al.,* 2008; Gleissman *et al.*, 2010; Vaughan *et al.*, 2013].

Sources of Omega-3 Fatty Acids

Omega-3 fatty acids are found naturally in several organisms such as fish (especially cold water fish e.g. salmon and tuna), plant oils (such as soybean and canola oils) and nuts and seeds (such as flaxseed, and walnuts). The most widely used source for DHA and EPA is fish oil, however, it is not recommended for the pregnant and nursing mothers because of the risk of bleeding caused by EPA [Ward and Singh, 2005]. Additionally, the fish stocks used for oil production have reached to extend due to several reasons such as growing human population and the presence of chemical contaminants (e.g. mercury) in fish oil [Shene et al., 2010]. High doses of fish oil in diet can also cause side effects including heartburn, nosebleeds and bad breath.

Krill oil, cod liver oil and algal oil are alternative sources for the production of especially DHA and EPA. Although fish oil covers a large share of the dietary supplements containing Omega-3 fatty acids, using especially microbial sources may decrease the prices and overcome the limitations of using fish oil [Martins *et al.,* 2013].

Among the microorganisms for omega-3 fatty acid production, *Phaeodactylum tricornutum* (diatom) and *Monodus subterraneu* (microalgea) are characterized for the production of EPA, *Cryptocodinium* (microalgae) for DHA production can be listed, however, *Thraustochytrium* and *Schizochytrium* (marine protists) are identified as the best microbial sources for production of DHA [Ward and Singh, 2005].

Microalgae are a rich source of nutrients with high amounts of amino acids, vitamins, minerals, carotenoids and fatty acids [Becker, 2004]. In addition, many beneficial health effects can be achieved through microalgae products that include antioxidant activity, immune-enhancing properties, lowering blood pressure and cholesterol, and promoting growth of beneficial microorganisms in the intestine [Jimenez-Escrig *et al.,* 2001; Hata *et al.*, 2002; Hirahashi *et al.*, 2002; Spolaore *et al.*, 2006; Dvir *et al.*, 2009].

Microalgae nutrient supplementation rich in docosahexaenoic acid (DHA) has been shown to increase DHA in cows' daily milk, porcine muscle tissue, and egg yolk [Becker, 2004; Sardi *et al.*, 2006; Stamey *et al.,* 2012].

***Schizochytrium* sp.**

Schizochytrium is a genus of unicellular eukaryotes in the family of Thraustochytriaceae. Thraustochytrids are obligate marine microorganisms that populate in nutrient-rich parts as in mangrove forests. Screening for strains with high DHA productivity may give successful results and the obtained strains may produce cell dry weight densities above 100 g/L in which the lipid accumulation between 50-70% of the cell dry weight with DHA percentage of 30-70 of lipids [Aasen et al., 2016]. *Schizochytrium* genus are heterotrophic organisms which include different strains; *S. aggregatum, S. mangrovei, S. minutum, S. octosporum, S. limacinum* which differs from each other based on formation, size and number of zoospores, morphological features and carbon profiles [Honda *et al.*, 1998].

Schizochytrium sp. is one of the most commonly used microalgae for PUFA production. Lack of algal toxins and high amount of DHA production makes them one of the most favorable microorganisms for DHA production. *Schizochytrium* sp. oil sample has been evaluated for gene mutation, clastogenicity and aneugenicity on rats and no negative effect was observed [FedorovaDahms *et al.*, 2011].

Besides using microalgae oil as DHA and EPA source, the powder form of *Schizochytrium* sp. can also been used as a whole which has an excellent nutritive value, rich source of essential amino acids, vitamins, minerals, carotenoids and fatty acids [Becker, 2004; Park et al., 2015] (Figure 2).

Figure 2: *Schizochytrium aggregatum algae cells, Schizochytrium oil and powder [URL2]* ***Schizochytrium*** **sp. Cultivation for DHA production**

The photosynthetic algal sources for DHA and other Omega-3 fatty acids have their advantages as being consumers of carbon dioxide and growing in salt water [Martins *et al.*, 2013]. In that case, PUFA yield depends on environmental conditions such as nitrate starvation, increased salinity, changing concentrations of carbon and nitrogen composition and their sources, and variations at light intensity [Honda *et al.*, 1998]. Overall, the photosynthetic production of Omega-3 fatty acids is not profitable due to low biomass density resulting in low production of PUFAs and longer period of cultivation.

Schizochytrium strains are heterotrophic organisms which can be cultivated in a shorter time period than photosynthetic algae. *Schizochytrium* is known for its bulging growth rate and enhanced capability to produce DHA quantity when grown on glucose, fructose or mannose

[Chatdumrong *et al.*, 2007]. Similarly, glucose, dl-malic acid, d-fructose, d-xylose and glycerol have been used as carbon source with successive cell growth and DHA yield of 20% in the biomass. In contrast, di- and polysaccharides caused limited cell growth [Shene et al., 2010].

Physiological conditions affect the yield of biomass and fatty acid composition [Patil and Gogate, 2015]. Excess of C and limiting N in medium usually result in lipid accumulation. In contrast, low amount of N causes reduction in cell growth which give rise to lower lipid and DHA yield. Honda et al. [1998] compared glucose, fructose and glycerol as carbon source which give the result of 32.5, 30.9 and 43.1% DHA in fatty acid composition.

The initial pH of medium is also effective on the DHA yield and total lipid accumulation by affecting cell membrane function and the uptake of nutrients. Wu et al. [2005] reported that the maximum DHA yield and biomass for *S. limacinum* has been achieved at pH 7.

Another determinant is the salinity of the medium which regulates the cytoplasmic ion gradient and activity of enzymes [Kim *et al.,* 2005]. Zhu et al. [2008] reported that lowering the salinity from 28 to 18% resulted in higher DHA accumulation.

Sahin et al., [2018a] used different media supplements; glucose, fructose and glycerol as carbon variants, proteose peptone and tryptone as nitrogen variants, to optimize the DHA production in *Schizochytrium* sp. Overall, the highest biomass and yield were achieved with proteose peptone as sole nitrogen source. The highest DHA yield was achieved with glycerol as C source even with lower biomass production. Ethanol addition after 24 hours, enhances the DHA production but yield is low because of decreased biomass production. There, it is suggested that combination of proteose peptone as nitrogen source and glycerol as carbon source, and addition of ethanol with a proper timing would increase the DHA yield. Fatty acid composition analysis is given in Table 1.

Table 1. *DHA and EPA fatty acid compositions (%w/v) according to Gas chromatography-FID analysis of obtained total fatty acids. CM complex medium (Control), CM+E complex medium and Ethanol, FM fructose medium, TM tryptone medium, GM glycerol medium, PPM proteose peptone medium [Sahin et al., 2018a].*

	CM	CM+E	FM	TM	GM	PPM
Omega-3						
Docosahexaenoic acid *(C22:6 n-3)*	29,94	40,04	26,53	24,81	48,75	34,13
Eicosapentaenoic acid *(C20:5 n-3)*	1,48	6,05	1,54	1,22	3,8	1,71

Symbiotic relationships can also be used to enhance the yield of DHA and biomass production. Generally, a photosynthetic alga is partnered with a heterotrophic organism in which they will form a mutualistic interaction. Sahin *et al.* [2018b] formed a symbiotic interaction by cultivating heterotrophic *Schizochytrium* algae with heterotrophic yeast *Rhodotorula glutinis* to enhance DHA yield in algae and β-carotene production in yeast cells. Here, the competition between the organisms for C and N sources might be effective on algae cells to enter a stress condition and microalgae DHA production was enhanced. Using co-culture increased cell dry weight ~2.6 fold while DHA and β-carotene yields were increased ~1.18 and ~1.76 fold respectively compared to *Schizochytrium*-monoculture.

Conclusion

Essential polyunsaturated fatty acids (PUFA) are important biomolecules for human health which cannot be produced (some produced inefficiently) by humans and other mammals. They should be taken from external sources in diet. Omega-3 and omage-6 fatty acids are two main groups of essential PUFAs. Docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are the two examples of Omega-3 fatty acids with countless positive effects on human health and development. They can even be used to inhibit cell proliferation and induce apoptosis in cancer cells. Freshwater microalgae, *Schizochytrium sp.*, is an alternative source for omega-3 fatty acid production, thus, the limitations of using cold water fish as source organism can be overcome. Optimization of growing conditions such as using alternative C sources, N sources and introducing symbiotic interactions may enhance the biomass production and DHA yield. The fatty acid oil extracted from *Schizochytrium sp.* contain high amount of DHA which can be used in baby food or animal food as nutritional additive.

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HISTORY, BOTANICAL CHARACTERISTIC FEATURES, BENEFICIAL OF HUMAN HEALTH AND GENERAL USING WAYS OF WOLFBERRY

CHAPTER 5

Halil İbrahim OĞUZ

INTRODUCTION

After the discovery of the berry fruits biotechnologic and pharmacologic characteristics, growing of wolfberry aroused curiosity around the world. Wolfberry is cultivated as a medicinal and aromatic plant since 4000 years ago in China. Wolfberry (*Lycium* spp.) is a genus of *Solanaceae* family and their most common commercial species are *Lycium barbarum*, *Lycium chinense* and *Lycium ruthenicum*. Wolf berry's common names are known Boxthorn, Matrimony Vine, Desert-thorn, Christmas berry, Duke of Argyll's tea tree as well as in *Gougi* in Chinese. Soever some researchers say that wolfberry is originate from Ningxia region, comparing to others wolfberry (gojiberry)'s hometown and its takes name is from Gojal, the part of the Himalayas that borders the Hunza valley [1]. Also, Koreans can call their berries like *kugicha* and the Japanese, who know it as *kukoshi*. Young leaves and dry root barks of wolf berry can consume as an herbal tea, functional vegetable, cosmetic products, wine, oil, milks, coffee, juice, seed etc. Wolfberries have got many different colorful berries such as yellow, purple, black, orange and red. For example, black fruits of *Lycium ruthenicum* also called "*Hei guo gou qi*" have been used as traditional medicinal plant in Tibetan and Inner Mongolian medicine but nowhere is wolf berry (*Lycium barbarum*) respectable more than in Ningxia Gouqi region of China which located along the Yellow River between Yinchuan plain, the Helan mountains and the Maowusu desert in the western part of China [1, 2]. Ningxia region is very suitable for growing of wolf berry because it has an extaordinary alkaline soil (pH 8.2-8.6) and an extreme high temperature range of from 38.5 °C to 27 °C. The demand for exotic plants is increasing in recent years. The reason is that have been used the biochemical compounds and extracts founding in the roots, leaves, flowers, fruits and shoots in folk medicine for many years in the pharmaceutical industry. In recent years, has been continued to draw interest about production and marketing of some medicinal aromatic plants, especially echinacea (*Ecinacea purpurea*), stevia (*Stevia* spp.), Quinoa (*Chenopodium quinova*), goldenberries (*Physalis peruviana*) and wolfberry (*Lycium* spp.) by both curious producers and researchers all over the world [33].

This chapter will cover the history, botanical characteristic features, beneficial of human health and general using ways of wolfberry.

History of Wolfberry

Its oldest record was discovered in the soothsayer bone manuscript (Jiaguwen) of the Shang Dynasty, which refers that wolf berry have been identified, grown and evaluated as early as in the Xia Dynasty which take places about 4000 years ago. And so far as the 1830s, Europe was also realized the surprising benefits of wolf berry. It was defined by J. Harvey von Bloom in Folk Lore, Old Customs and Superstitions in Shakespeare Land, London. Wolf berry was known to be a superior herb as early as the first century A.D., when it was emblazoned in the Divine Farmer's Handbook of Natural Medicine *(Shen Nong Ben Cao)* which probably the most significant text in the history of Chinese Medicine. Other example is Tao Hong Jing (456-536 A.D.) who was a Taoist Master and wrote a dissertation called Commentary on the Divine Farmer's Handbook of Natural Medicine. Tao Hong Jing tells us that "*Lycium* tonifies *jing* (life-sustaining energy) and *qi* (breathe) and intensifies the *yin tao* (capacity for physical exercise) within a human" [1].

Botanical Classification

Botanically it belongs to *Solonaceae* family and the most common types are *Lycium barbarum* and *Lycium chinense.* Wolf berry is a leaf shedding plant in bush form. Its leaves have a leaf form that ranges from spear shape to circular shape. The leaves and its sprouts are aligned on the branches of trees in bunches, in opposite directions. Leaves are 7 cm long and 3,5 cm wide. It has a grape-like fruit that is colored, shiny, ellipsoid and 1-2 cm long. Its fruits have an ellipsoid form and mandarin or orange-red color. While the sizes of their fruits change from type to type, one fruit contains 10-60 pits. *Lycium ruthenicum* is a goji berry type that is known as "Qiao Nuoying – kharma" in Mongolia which is especially rich in protein. It is also a type that is quite rich in black flat, sweet, polysaccharides, amino acids, trace elements and other elements. It is also richer in pigments and natural procyanidins than *Lycium barbarum*. It has a dicotyledonous flower structure. The flowers originate on 1-2 cm thick branches. Petals are in tubular spandrel lobes. Petals are lavender shaped, light purple colored and have 6 lobes with 9-14 cm width. The flowers are self-fertile. Since bee activity increases fertilization, in terms of fertilization biology, they belong in entomophilous group [3]. Researchers reported that the wild *Lycium* resources have high level genetic differences. The molecular investigations indicated that wolfberry has a resistant gene structure due to its secondary metabolism, against plant diseases and pesticides. The researches have been working on the wolfberry plant's resistance to diseases and pests. Recently, wolfberry industry has improved quickly in worldwide.

Figure 1: *Drying process of fruits (Aksaray)*

Figure 2 *: Harvesting (Aksaray)*

Concordantly, drying techniques of wolfberry has been developed. At the same time, plant breeder improved new species of wolfberry which has features suitable to mechanical harvesting [2]. A recent study by [4], young leaves of wild *L. chinense* has a substantially higher amount of polysaccharide than the wild *L. barbarum* plants (10.72 vs. 7.86 mg/g). It was observed that the difference of polysaccharide amount between different populations of each species was not important, but the difference among genetic characterizing of individuals within each population are more important rather than environmental differences. It is understood that polysaccharide and total flavonoid of amounts are very significant breeding criteria.

 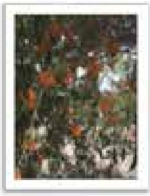 

Figure 3 : *Lycium barbarum* Figure 4 : *Lycium chinense* Figure 5 : *Lycium ruthenicum*

The General Usage of Goji Berry Plant

Both the fresh and dried fruits and leaves of the goji berry have multipurpose use. For instance, they are used in the making of cakes and pies, snacks and appetizers, salads, breads, drinks, food supplement, wine, yogurts, crisp, drug productions, tea, coffee, soups, seeds, oils, beers, liquors, cosmetic products, marmalades, main courses, breakfast foods and cookies [5]. [2] carried on a study reported that Fang Xuanling reported that a renowned prime minister in the Tang Dynasty became fagged out in his body and mental fatigue over activity. Nevertheless, he pulled through by keeping having the wolfberry tremella soup. Also, they indicated that wolfberry has been consumed as a good herbal tonic for a long time. Cause of tonic effects, in Chinese history, people longer and healthier lived. In the period of the First Emperor of the Qin Dynasty (Qin Shihuang), wolfberry is significant component of the three detected medicines with confidential recipes.

Figure 6 : *Lycium barbarum*

Benefits of Human Health

In traditional Chinese folk medicine, medical remedies were made from root shells (Digupi) and fruits (Gouqizi) of goji berry plant. It is also told that its leaves and seeds are used in some medicinal herbs books [6]. The dietary intake of berry fruits has a positive and profound impact on human health, performance and disease. All these fruits support the immune system and are nutrient dense. In general, they have an extraordinary concentration of antioxidants, monounsaturated fats, dietary fiber, phytosterols, essential amino acids, valuable trace minerals, and vitamins (A, C, B1, B2, B6, B12, etc.) [7, 8]. Also, Goji's betaine and master molecule polysaccarides can restore and repair damaged DNA, protecting your body's ten trillion cells [1].

Prevalent pharmacology investigation has clarified that immune regulation is the fundamental biological effect of *Lycium barbarum*. Research shows that the main material bases to reveal the effect of *L. barbarum* on the immune system are polysaccharide and glycoprotein complexes, additionally other substances such as volatile oils, vitamins, and so on, which also labor certain immune effects [9].

Goji berries are used in traditional Chinese folk medicine to produce the Yin tonics that were used in the treatment of liver, kidney and lung diseases. These tonics are also used in the treatment of diseases such as blurred vision, acute vision problems, headache, infertility, abdominal pain, dry cough and fatigue [10, 11]. It is also believed in folk medicine that goji berry fruits prolong life span and prevent the occurrence of gray hair [12]. It is also used in drinks and soups for diet purposes [13]. In Chinese folk medicine root shells of goji berry are used as immune system booster when there is no Yin 6-15 grams of root shells are boiled and consumed as a drink. It helps with colds, treatment of cough and fending of viruses from the body in mildly inflammatory diseases by stimulating sweating. It is also used in the treatment of diseases such as hypertension, hemoptysis (coughing up blood) and hematuria (bloody urine) [11, 13, 14, 15, 10]. Goji berry is a very important fruit for human health with its multiple pharmacological functions, anti-aging property, high antioxidant and phenolic compound content, immune system boosting properties and anti-tumor activities [16, 17, 18, 19]. The AA-2βG chemical component present in goji berries is found to be 0.5% more in dried ones. Goji berries are natural sources of AA-2βG. AA-2βG can be used as a regular AA source [36, 37]. Moreover, goji berry is used in China to stop the conception and progress of cancer in the field of alternative medicine. It is known that it also boosts the immune system [20]. Chinese people accepted it as sacred plant since it is important for health [21]. When some researchers compared the carotenoid and lutein content of leaves and fruits of goji berry plant with those of spinach, they found that carotenoid content is 3 times more and lutin content is 5 times more in goji berry leaves than spinach. As is known, bioflavonoids can easily be dissolved in water and have antioxidant and inflammation relieving properties. Bioflavonoids can also support the immune system of our body against viruses, carcinogenic substances and allergic reactions. In addition, alpha-beta carotene has anti-carcinogenic (cancer-prevention) features. Additionally, wolfberry is used in China to stop the conception and progress of cancer in the area of alternative medicine. It is known that it also boosts the immune system [20]. Chinese people accepted it as blessed plant since it is significant for human health [21]. Furthermore, more than 100 human diseases have been notified to be related with free radicals [22]. Phenolic comprise flavonoids from plant foods authenticated to have effects on radical scavenging, antioxidation, and anticancer. Flavonoids are the considerable active compounds present in the leaves of *L. barbarum* [23, 24]. *L. ruthenicum* is other Chinese folk medicine used for the treatment and prevention of heart disease, unnatural menstruation and menopause [25]. A study was carried out in China, the functional compounds in the black fruit of *L. ruthenicum* are primarily comprised of anthocyanin, essential oils and polysaccharides [25]. As the principal pigment in red fruits, carotenoids had been extensively studied, and zeaxanthin and esterified zeaxanthin were notified to be the major bioactive compounds that collect in red fruits, particularly for its conventional use in eyesight advancement [26, 27]. However, some researchers inform that the berry fruit properties of the carotenoids in black berry fruits have not been extensively notified, and the mechanisms controlling the species differences in the carotenoid biosynthesis between red and black berry fruits remain unknown. Medical herbals contain natural phytochemical substances and have active components which can help in cancer chemotherapy [28]. [29, 30], proved that Chinese wolfberry has an antitumor effective and to be less toxic. Also, they obtained active ingredients which are responsible for the biological activities from isolated aqueous extracts of *L. barbarum*. These biological activities have antioxidant properties, antiaging effects, enhancement metabolism, developed control of glucose, antitumor activity, antiglaucoma effects, immunomodulation, cytoprotection, neuroprotection and other diabetic symptoms. Aging process can effect to brain cells adversely. Especially, these cells sensitive to oxygen deficiency because these deficiencies can cause loss of memory, absence of perception, forgetfulness. The major cause of Alzheimer's diseases are the low levels of choline and free radical activities. Goji berry produces an enzyme that inhibits the production of lipid peroxidase enzyme, which causes the loss of myelin causing damage to the nerve cells. As a result, wolfberries' flavonoids have a role to protect against narrowing arteries and keeping them open so they can reach oxygen and essential nutrients to brain cells [32]. Hormonal changes levels can also cause sleeping problems and result in heavy, irregular or lengthy menstrual periods. Men and women get older, erectile dysfunction is observed extensively in men, menopause, low levels of estrogen and progesterone hormones are observed in women. So, wolfberry can be used for these common situations of people. Also referred to as impotence, Erectile dysfunction is the loss of skill to have and maintain an erection firm enough for sexual relationship. One study at National Institute on Aging, by age 65 about 15 to 25 percent of men have this problem at least 0ne out of every four times they are having sex. This may occur in men with heart disease, high blood pressure or diabetes either because of the disease or the medicines used to cure it Wolfberry have been traditionally regarded in Asia as a longevity, strength- building and sexual potency food of the highest older. Also, nearly all patients reported improved appetite and better quality of sleep. More than 35 percent of the patients saw a marked recovery of sexual function. According to herbalist Ron Teagarden, in Chinese studies, wolfberry was shown to markedly increase testosterone levels in the blood, increasing libido in test subjects. Furthermore, wolfberry boosts stamina. An animal study showed that goji's master molecule polysaccharides induced a remarkable increase in exercise tolerance and stamina helped to eliminate fatigue. When taken orally, it markedly increases androgen levels in the blood, making patients feel more energetic. So potent is the wolf berry that an Ancient Chinese proverb cautions men who are travelling far from their wives and families as follows: "He who travels one thousand kilometers from home should not eat goji"[1]. [31], indicated that *Lycium barbarum* polysaccharide treatment inhibited the growth of colon cancer cells which are called SW480 and Caco-2 cells. According to their study's result is that *Lycium barbarum* polysaccharide is applicant anticancer agent and has long term antiproliferative effect.

Figure 7: *Aksaray*

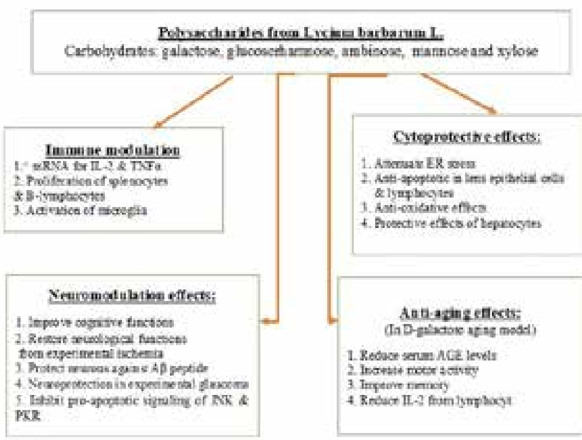

Figure 8 : *Summary of biological effects of Lycium spp. [34]*

Conclusions

The popularity of wolfberry plant is increasing day by day through the agency of media and communication broadcasts. in this study, it was aimed to giving information about history, botanical characteristic features, beneficial of human health and general using ways of wolfberry. Studies have shown that wolfberry plant cultivated and used as a folk medicine for a long time in China because of these reasons wolfberry plant has a significant value in traditional China culture. For example, In Chinese literature, poets, writers mentioned about wolfberry in their masterpiece. In Tang Dynasty's well known poet Liu Yuxi (772-842 A.D.) was written poem about wolfberries. Especially, in this study, it was aimed to emphasize beneficial of wolfberry for human healthy. It contains 19 amino acids, 21 trace minerals, antioxidant carotenoids, beta-carotene, zeaxanthin, vitamin C, essential fatty acids, cyperone, solavetivone, physalin, betaine [1]. As a result, to sum up benefits of worm grape to human health; wolfberry can fight with free radical by containing extremely high in vitamin C and A. Its protect salvaging from oxygen damage the cell by the help of antioxidants, riboflavin, selenium which is also abundant wolfberry. Also, the ellagic acid in wolfberry acts as an antioxidant by reducing oxidative stress. wolfberry involve potent antioxidants that lower blood glucose levels, and sum cholesterol and triglyceride concentrations, while increasing high-density lipoprotein cholesterol levels. Therefore, wolfberry Support cardiovascular health. The to a high degree of vitamin C in wolfberry preserve your phagocytes and T-lymphocytes against free radicals consist of during the interaction of these immune system cells with pathogens, and thus continue the collectivity of these infection-fighting cells. Wolfberry gives a leg up to immune system function due to containing in high quantity of vitamin A. Also wolfberries were it has been long known to increase white blood cell count and strikingly increase the antibody. Wolfberries prevent sight impairment owing to rich in antioxidants, particularly carotenoids such as beta-carotene and zeaxanthin. Zeaxanthins play a significant role to protect the retina of the eye by absorbing blue light and acting as an antioxidant. Wolfberries berries can decrease DNA damage and protect against DNA damage. Wolfberry has anticarcinogen features cause of contains densely vitamin C.

The ellagic acid in wolfberries blocks the DNA binding of certain carcinogens. One study in 1994, researchers found that 75 people with cancer responded better to treatment when wolfberry was added to their diet. Wolfberries hindered the growth of leukemia cells. Goji berry polysaccharides trigger production of interleukin-2, a hormone-like substance that warns the growth of blood cells significant to the immune system, which preserve against cancer cells. Wolfberry's another feature is that can improve your skin. Because wolfberry has high in astaxanthin, an antioxidant known as "natural sunscreen" that helps reverse and protect from sun damage. Wolfberry also contains more beta-carotene than carrots. Beta-carotene (which converts to vitamin A) helps fight inflammation and encourages new skin cell growth [35].

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LIGHT AND LED LIGHTING USE IN AGRICULTURE

CHAPTER 6

İlker Hüseyin ÇELEN[1]
Eray ÖNLER[2]

1 Tekirdag Namik Kemal University Faculty of Agriculture, Biosystem Engineering Department Süleymanpaşa, Tekirdağ ,Türkiye
icelen@nku.edu.tr
2 Tekirdag Namik Kemal University Faculty of Agriculture, Biosystem Engineering Department Süleymanpaşa, Tekirdağ ,Türkiye

INTRODUCTION

The continuous increase in food demand in the world, the decrease in the proportion of people living in rural areas and the contraction of agricultural production areas have necessitated the transition from traditional methods to advanced methods in agricultural works where human labor is heavily used. It is acknowledged by everyone that the increase in the use of environmental pollutants in agricultural production for the last fifty years has caused the deterioration of the agricultural environment and the decline in food quality.

The continuous increase in the human population renders both nutrients and habitats inadequate. The surface of the Earth is not infinite. Looking for another living space, going to other places in the world is far from utopian when compared to our lives, but not far from the astronomical scale. That is why life outside the world attracts today's people. In addition to finding a place to live in space, it is also important to provide the nutrients needed to survive.

One of the biggest problems for the colonization and transportation of human beings on an extraterrestrial planet is the lack of nutrient requirements. In other words, the necessity of agriculture in space. Soil inefficient and scarce, sufficient light and temperature requirements are some of the factors that should be considered. Many scientists are developing new solution techniques to work on these issues.

Space agriculture plays a major role in maintaining our existence in space without being dependent on the world and in constant communication with the world. Although it seems like a simple process, all the secrets are hidden in the details. Among the experiments carried out by ISS (International Space Station), space fields are of great importance. The first greenhouse in space was established in 2000, two years after the astronauts went to stay. In addition to this agricultural field, which is built on deck, another system is being carried out in the European Modular Insemination System and different researches are carried out on the plants. As the duration of manned tasks increases both in terms of food and psychological sense, the importance to the plant increases. The first experimental plants were grown in mini experimental fields in the ISS (Toothman, 2018; Tunç, 2018).

The orientation of the roots and stems of plants on earth is realized by gravity. Given that there is no gravity in space, this orientation is not known. The desire for gravity, which is necessary for the human body to survive, is the same in plants. In the studies, the plants found in the space underwent some interesting mutations, prolonged in undesirable and unpredictable ways, and often did not flourish or even grow. Various problems have arisen in the production of second generation fertilizable seed which will play a major role in sustainable space agriculture (Slezak, 2014). Besides, it is thought that plant-soil relationship will be different in these areas where mass gravity is different, there will be problems in water, moisture and air flow, and if these communities want to produce plants and each waste in their hands fails to recycle the atomic molecules, some additional foods are needed.

Besides, there is no problem in reaching the light of plants in the world. What will happen in space is unknown. However, it is necessary to meet this need of plants if it is considered to be cultivated in greenhouse or growth rooms. It is necessary to investigate how long the artificial light will be given. In addition, inefficient and energy-consuming bulbs that use a lot of energy will not be used in space. LED (Light Emitting Diode) called continuous and small light sources have been demonstrated by many researchers to provide great benefits (Yorio et al., 2001; Anonymous, 2011; Teke et al., 2011; Köksal et al., 2013).

When we return from urban dream to urban life, we see the advantages of LED. Since 2007, more than half of the world's population has been living in urban areas and more than 70% of the world's population is estimated to live in urban areas by 2050. Recently, more and more people are interested in urban agriculture or vertical agriculture. Indoor, urban agricultural areas (flower pots, plant tables, etc.) need complementary artificial lights. Even open spaces (public green spaces in public areas, private vegetable / flower gardens, orchards) need this light.

Urban agriculture has two main functions. One is to make people enjoy horticulture as a hobby, and the other is to produce food or sell ornamental plants locally. For regional consumption, production, labor, packaging transportation, fossil fuel consumption and transportation related damages are saved in the region. In addition, employment opportunities are increasing. The consumer benefits from more varieties and more fresh vegetables and fruits.

Since land prices in urban areas are high, the annual production efficiency per unit area is considerably higher in these areas and greenhouses than in open areas. The annual productivity of lettuce plants in the unit area is approximately 200 times higher in LEDs and about ten times higher in greenhouses than in open areas. If the soil is not fertile enough to grow plants (contaminated with toxic chemicals, heavy metals, etc.), artificial hydroponic systems isolated under the soil may be used.

In this study, artificial light sources, which we will have to use in the future and the effect of its use on today's agriculture, and the studies and results obtained from the past to the present are compiled. First of all, it is necessary to get to know the relationship between light, lighting and plants.

Light and Lighting

Light is the most important environmental variable related to plant growth. Plants use light energy from the sun to produce a source of nutrients through photosynthesis and are autotrophs. As shown in Figure 1, in photosynthesis the plant binds water, hydrogen and carbon dioxide using light energy, resulting in carbohydrate and oxygen. Photosynthesis, biochemical light reactions rather than; different properties of light and their effects on photosynthesis should be known. Quality (spectrum), quantity (intensity) and duration (photoperiod) are the light properties that affect photosynthesis.

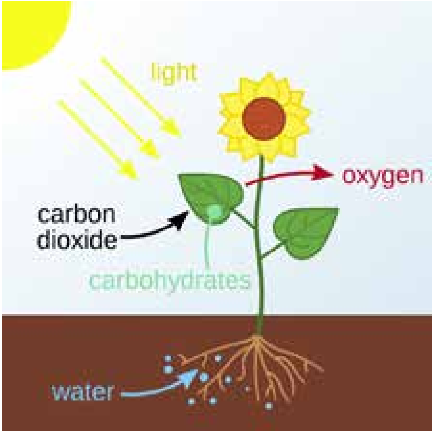


Figure 1. *Light effect in photosynthesis (Anonymous (a), 2019)*

As an effective factor for plants, we need to recognize this factor in order to understand how light affects plants. Light refers to visible light through its widespread use. Electromagnetic waves, which can be perceived by the human eye, that is to be seen by humans, are called visible light. The wavelength of visible light is between 380 nm and 760 nm. In the electromagnetic spectrum, this area lies between infrared and ultraviolet. The wavelength of visible light is shorter than infrared and longer than ultraviolet (Yüce, 2017).

The electric field and the magnetic field, each containing magnetic and electric field fragments (photons), hold each other tightly and travel as if dancing in space. Each electromagnetic wave has a wavelength (Gürdal, 2017). While the wavelength of high energy gamma rays is smaller than the hydrogen atom, it can be said that the lengths of low energy radio waves are as large as the width of Jupiter (Cengiz, 2019).

The wavelengths of the lights in the visible light region correspond to 1% of the thickness of the human hair, and in the electromagnetic spectrum this corresponds to a very small fraction. We can only see lights with wavelengths between 400 and 700 nanometers.

Each light has a specific source. The largest and most powerful light source in the world is the sun. In order to continue life on earth, sunlight must be present. The light-receiving side of the Earth is bright and the light-free side is dark. We use the sources of light to see beings in the dark. The sun, the stars, the electricity, the fireflies, the gas lamp. Natural light sources are not self-produced and self-generated. Sun, stars and lightning are the examples of light sources. Examples of artificial light sources include electric bulb, flashlight, torch, LED, car shadow and candle.

When white light, which is a mixture of all colors, is passed through the prism, purple, blue, green, yellow, orange and red colored light bands are formed. In the visible light spectrum, the wavelength is the longest red light and the shortest is purple light.

The amount of energy is inversely proportional to the wavelength of light. Long wavelength energy is low, short energy is high.

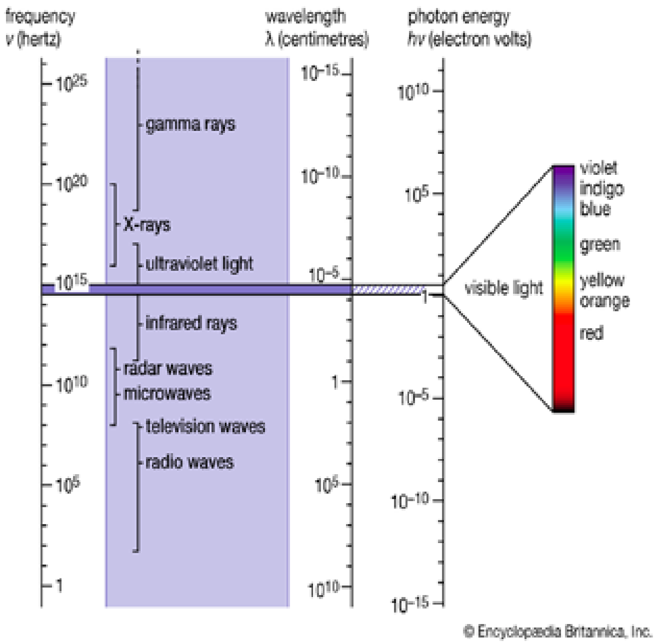


Figure 2. *Electromagnetic spectrum (Anonymous (b), 2019).*

The effect of color factor on plant growth

Visible light-absorbing substances are called pigments. Different pigments absorb light of different wavelengths, while transmitting or reflecting unabsorbed rays. If white light is sent to a pigment, the light reflected or transmitted by the pigment creates the color that our eye can choose, allowing us to see the objects in different colors. The light rays absorbed by chlorophyll are used in photosynthesis. Because the chlorophyll reflects or transmits green light, the leaf appears green. Pigments involved in photosynthesis:

a-Chlorophyll: It is a green pigment that absorbs the rays of various wavelengths and provides photosynthesis in the plant. Chlorophyll is found in cell membrane folds in prokaryotic cells and in echaryotic cells in tiloplastic structures of chloroplast. Chlorophyll is composed of C, H, O, N and Mg atoms. There are 20 types of chlorophyll molecule, called chlorophyll a, b, c, d, and e. The most common of these is chlorophyll a and chlorophyll b. Ofil Chlorophyll a doğrudan plays a direct role in converting light energy into chemical energy. It is therefore the most important pigment for photosynthesis. Ofil Chlorophyll b yardımcı helps photosynthesis by transferring the absorbed light energy to "chlorophyll a". Chlorophyll a, in all green plants; chlorophyll b is found in some green plants and some algae.

As seen in Figure 3, when chlorophyll a is examined in the spectrum, it is seen that purple and red light are most effective in photosynthesis whereas green light has the least effect.

b-Caratenoids: Pigments such as orange carotene, yellow xanthophyll, red lycopine. Carotenoids give color to flowers and fruits. It can also absorb rays of different wavelengths that chlorophyll cannot absorb. The absorbed light rays are then transferred to chlorophyll and used in photosynthesis. Some carotenoids, however, also emit excess light, which will damage chlorophyll.

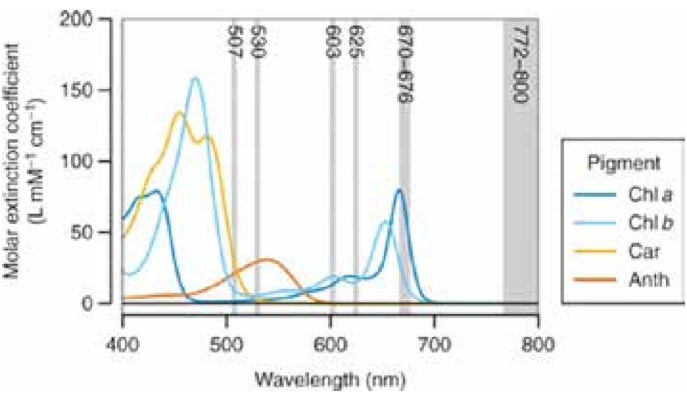


Figure 3. *Spectroscopy of different color pigments in chloroplasts (Photo-absorbtion) (Matsuda et al., 2012)*

Plants and people perceive light very differently. Humans and many other animals use a function called photopic vision in well-lit conditions to detect color and light. Since the lumen is a unit of measurement based on the human eye sensitivity model in well-lit conditions, this is called a photopic sensitivity curve (Figure 4). This curve shows that people are more sensitive to green light than blue or red light. LUX and foot candel measure light intensity (using lumens) for commercial and domestic lighting applications, the only PAR measured between the two is the measured area unit. In other words, LUX uses lumens / m^2, while foot candel uses lumens / ft^2.

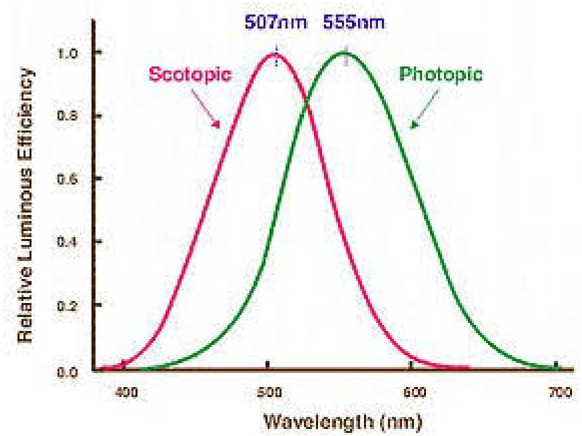


Figure 4. *Photopic sensitivity curve (Anonymous (c), 2019)*

The use of LUX or foot candel to measure the light intensity of agricultural lighting systems will provide measurements that vary depending on the spectrum of the light source, even if photosynthetic active radiation (PAR) shows the same intensity.

The main problem with the use of LUX or foot candel when measuring the light intensity of agricultural lighting systems is the lack of blue (400-500 nm) and red (600-700 nm) light in the visible spectrum. Humans may not be effective in detecting light in these areas, but plants use red and blue light to perform photosynthesis. Therefore, the lumen, LUX and foot candel should not be used as a metric for agricultural lighting.

LUX RATING CHART

		Light Level (LUX)	Foot Candles (FC)
Day Time	Sunlight	107.527	10,000
	Daylight	10,752.70	1,000
	Overcast Day	1,075.30	100
	Very Dark Day	107.53	10
	Twilight	10.75	1
Night Time	Deep Twilight	1.08	0.1
	Full Moon	0.108	0.01
	Quarter Moon	0.0108	0.001
	Starlight	0.0011	0.0001
	Overcast Night	0.0001	0.00001

Figure 5. *Daylight intensity at different times (Anonymous (e), 2019)*

PAR is photosynthetically active radiation (Figure 6). It is defined as electromagnetic radiation in the wavelength range of 400 to 700 nm, which can be used as an energy source for photosynthesis by green plants. PAR is a commonly used (and often misused) term for agricultural lighting. PAR is not a measurement or a "metric gibi, such as m, da, weight. On the contrary, the type of light required to promote photosynthesis is defined. Spectral light quality and quantity of PAR light are important parameters. Quantum sensors are the primary tool for measuring the light intensity of agricultural lighting systems. These sensors operate using an optical filter to generate an equal sensitivity to PAR light and can be used with a light meter to record the instantaneous light intensity or with a data recorder to measure the cumulative light intensity (Pashiardis et al., 2017).

PAR is a key variable in a wide variety of ecophysiological models, both at the leaf photosynthesis level and at the crop production level. Therefore, the precise estimation of PAR value is important for assessing and modeling plant growth and biological production management in different vegetative ecosystems. Monteith and Unsworth (1990) suggested that net primary production under certain conditions was linearly correlated with the amount of PAR absorbed by green leaves.

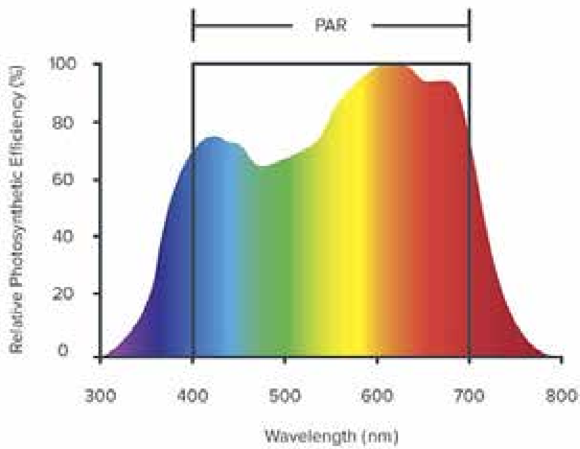


Figure 6. *PAR (photosynthetically active radiation) (Anonymous (d), 2019)*

The radiation incident in a plant canopy comes directly and as scattered minds. The direct flux is formed by photons passing through the non-dispersed atmosphere, while the diffuse flux consists of photons scattered by air molecules, aerosol particles or clouds. Depending on the aerosol charge and solar height, the ratio of dispersed PAR to spherical PAR radiation on a horizontal surface ranges from 20-40% (Jacovides et al. 1997). Only photons absorbed by the shade can be used for photosynthesis. For radiation use efficiency calculations, a constant absorption coefficient of 0.85 to the incident current was proposed (Sinclair and Muchow 1999).

When researching agricultural lighting systems, it is necessary to know how much PAR is produced by light source, how much PAR can be used, and how much energy the luminaire uses to make PAR available (Photon Efficiency).

The three basic metrics used to answer these questions are;

- PPF (Photosynthetic Photon Flux),
- PPFD (Photosynthetic Photon Flux Density),
- Photon effectiveness

PPF (Photosynthetic Photon Flux)

PPF indicates the total amount of PAR generated by a lighting system for each second. This value is taken using a special tool called an integrated sphere that captures and measures all photons emitted by a lighting system. The unit used to express PPF is µmol / s. With this we can also measure an agricultural lighting system. Most lighting companies cannot express this metric. PPF is important for calculating the efficiency of the lighting system in creating PAR. However, we cannot obtain information about how much light reaches plants.

PPFD (Photosynthetic Photon Flux Density)

PPFD is actually the amount of PAR that occurs in the plant. In other words, the number of photosynthetically active photons falling on a given surface per second. PPFD is a "point" measurement of a specific place in your vegetation and is measured in micromoles per square meter per second ($\mu mol / m^2 / s$) (Pashiardis. 2017).

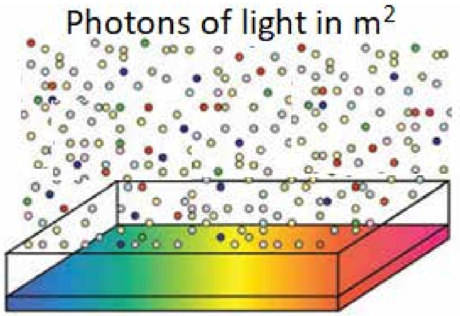


Figure 7. *Photons (400-700 nm)*

If you want to know the actual light intensity of a lamp over a specified area, several PPFD measurements should be averaged at a defined height. Lighting companies, which only broadcast PPFD at the center of a coverage area, overestimate the actual light intensity of a luminaire. Since agricultural lighting is often the brightest in the center, a single measurement doesn't tell you much. The light levels decrease as measurements are taken towards the edges of the coverage area. In the literature and catalogs, the average PPFD at a given installation height can always be found over a defined growth area recommended for all lighting systems (Pashiardis, 2017).

Photon Effectiveness

Photon Effectiveness expresses how efficient an agricultural lighting system is in converting electrical energy into photons of PAR. Many agricultural lighting manufacturers use total electrical watts or watts per unit area as metric to define light intensity. However, these metrics do not specify anything, since watt is not a light output but a value defining electrical input. Lighting systems are very effective in the conversion of electrical energy within PAR photons. If the PPF of the light is known with the input voltage, it can be calculated how efficient an agricultural lighting system is in converting electrical energy to PAR.

Photosynthetically active radiation (PAR) is the main driver of photosynthesis in plants. However, not all wavelengths of light are equally effective in the process of photosynthesis. McCree (1972), Inada (1976) in the PAR curve developed by Red light (600-700 nm) photosynthesis while blue light (400-500 nm) seems to be almost twice as effective. Green (500-600 nm) light is located between the two (Figure 3).

A general misconception; Chlorophyll absorbs light from the red and blue parts in the visible light spectrum (which leads to the green color in the leaves) and that green light is not used by plants for photosynthesis. However, studies have shown that precise and independent measurements of photosynthetic activity at different wavelengths, light in the green spectrum (500 - 600 nm) are almost as effective as blue light for a significant number of plant species (Terashima et al. 2009). Plants produce both biochemical and biophysical solutions to use green light. Examples are auxiliary pigments. These co-pigments (mainly carotenoids) can be considered as storage molecules for photons that are not directly absorbed by the chlorophyll.

The number of photons absorbed by specific photoreceptors (Chloroplast) directly affects the rate of photosynthesis. As the light intensity (PPFD) increases, the rate of photosynthesis increases until the saturation point is reached. Each plant species has different light saturation points based on the light environment in which they develop. Light saturation occurs in plants grown under shade conditions at much lower concentrations than those grown in full sun conditions. However, when other factors (CO2) are limited, light saturation normally occurs (especially in solar plants) (Figure 8).

Another light intensity value is the minimum light intensity required. Plants need the minimum light intensity required to survive, grow and develop. As expected, this point occurs at higher light intensities for plants grown in the sun than plants grown in the shade. Ensuring adequate spectral light quality and sufficient light intensities is critical to supporting plant growth.

Lighting systems in horticultural plants can be used to promote photosynthesis and increase light intensities. It can be used in greenhouses where lighting is limited (in northern latitudes, cloudy weather or indoor cultivation). It is also preferred in environments where sunlight is not used as a source of photosynthesis (eg growth chamber, storage, growing tent, etc.). One of the most important advantages of using LED for all applications is the low thermal output on the surface of the diode. HID (low pressure sodium vapor) lamps as infrared (IR) light are installed at a certain distance from plants due to their high energy emission. Therefore, it is limited to achieve very high PPFD with HID lamps. The IR light is photosynthetically inactive and significantly increases plant temperatures, thus delaying the distance between the plant and the light. This results in reduced light intensity and limitation of the environments that can be used in the facilities. Since it can be used in places with high ceilings, light intensity decreases. The LEDs emit most of the heat from the back of the diode. This allows the luminaires to reach very high levels of PPFD and be placed at closer distances than the crop canopy (≥ 1000 μmol / m. This is to increase the distance between the light and the crop canopy (which results in reduced light intensities and limitation of the space available for long ceilings). With heat management, LEDs can dissipate most of their heat from the back of the diode, thus supporting plants to grow with high PPFD (≥ 1000 μmol / m^2 / s).

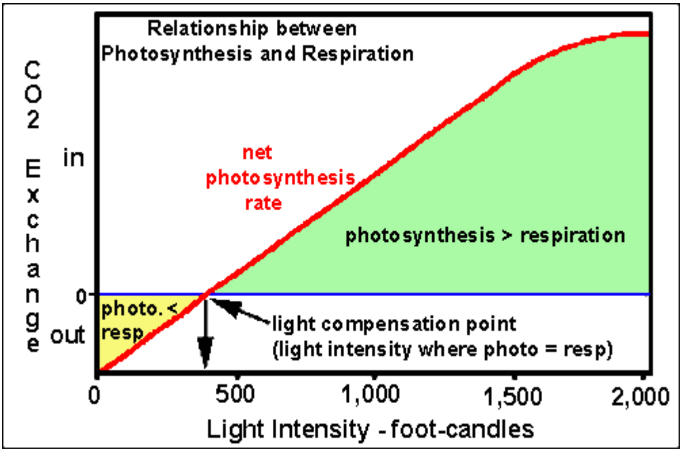


Figure 8. *Light intensity (Anonymous (h), 2019)*

The development of plants depending on the day length is called photoperiodism. The stage in which plants develop is called photoperiod.

Photoperiod affects the physiological events such as growth, development, flowering, foliage and beginning of stagnation in plants. Buds form flowers; however, the photoperiod is determined by the leaves. When the photoperiod required for flowering is provided, the leaves must send a signal to the buds to form a flower. If all leaves are removed, the plant becomes blind to photoperiod.

The plants can be grouped as long day plants, short day plants and neutral plants according to the time of receiving light.

Long day plants are the plants that bloom in the spring and summer, on days when the day is longer than the night. Examples are barley, wheat, dill, sugar beet, radish, rye and spinach.

Short day plants are plants that bloom and develop during the seasons when nights are longer than the day. Plants such as strawberries, spurge, crowbar, soybeans, tobacco, potatoes and chrysanthemums are examples of short day plants.

Plant species not affected by day length are called neutral day plants. Flowering and development of these plants are not affected by photoperiod. Therefore, neutral day plants are more advantageous than long day and short day plants. Cotton, tobacco and sunflower are examples of neutral day plants.

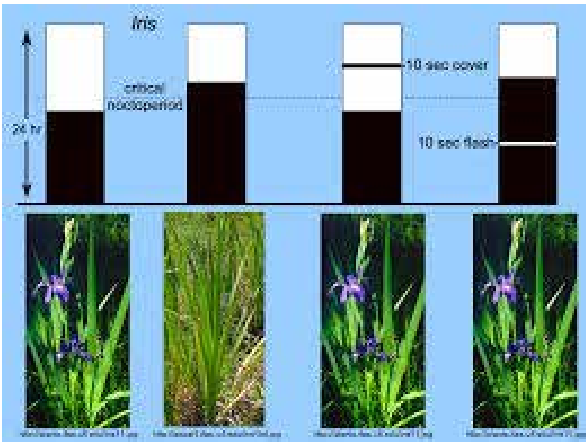


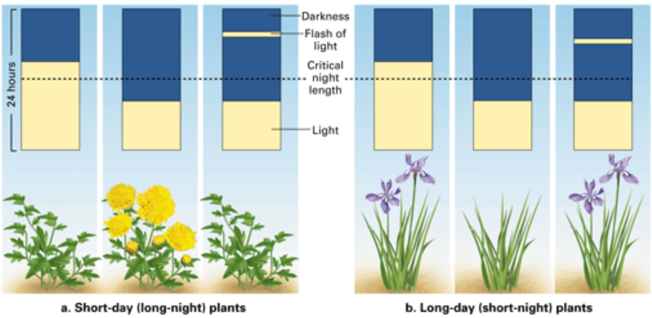
Figure 9. *Light times in plants (Anonymous (f), 2019)*

Under natural conditions, day and night lengths shape the light and dark cycle of the 24-hour process. The researchers found that the control of other responses to flowering and photoperiod was not length of day, but length of night. This factor, called critical night length, is the length of night or the number of dark hours required for flowering short day plants or preventing flowering in long day plants. The critical night length is the minimum number of short day plants and the maximum number of dark hours in long day plants. For example, in the short-day plant, the hearth, the critical night length is 8.5 hours. Flowering occurs when the night length exceeds the "critical dark time" in this plant. However, even when the night portion of the photoperiod illuminates for a few minutes, ie when the night is interrupted, there is no blooming in the velcro plant. Therefore, other short day plants, including the velcro, need the continuity of the night period, ie, not interrupted by light, for flowering. In short day plants, however, interrupting the daytime portion of the photoperiod with a short dark period has no effect on flowering. Long day plants do not bloom on long night photoperiods where short day plants bloom. However, if the period of continuous darkness is disturbed by light, they bloom. In long day plants, flowering occurs when the night length is shorter than the "critical dark time".

Light time (photoperiod) is expressed as the time during which a plant is exposed to light for a period of 24 hours. The length of a photoperiod can affect the overall light intensity a plant receives within 24 hours, which affects overall growth. This is defined as a discharge PPFD for 24 hours and is described as integrated daily light (DLI LI-day light intensity). This unit is expressed in mol / m2 / d. Photoperiod affects the transition from vegetative growth to reproduction in various plant species. In fact, this is the dark period (scotoperiod) and it is not the photoperiod that determines when certain species will go into reproductive development. Photoreceptor phytochrome is responsible for reporting the transition to reproductive growth in photoperiodic plants.

If phytochrome detects a continuous long night (usually 12 hours), short day (long night) crops bloom. Long day (short night) plants bloom during the short night (usually 12 hours). Alternatively, for several plant species, the day is neutral, where the photoperiod does not affect flowering.

It can be used to provide photoperiodic light to stimulate the flowering of long day plants or to prolong the day in order to prevent flowering of short day plants regardless of climate. Traditionally, HID, incandescent or fluorescent lamps have been used to provide photoperiodic lighting in greenhouses. However, these technologies are relatively unsuccessful in converting electrical energy into PAR. LED lighting systems are more successful in converting electrical energy to PAR.



a-Long-day plants bloom on short nights, short-day plants do not bloom

b-Long-day plants do not bloom on long nights, while short-day plants bloom.

c-If long nights are interrupted by light, long day plants will bloom and short day plants will not bloom.

Figure 10. *Effect of photoperiod on short and long day plants (Anonymous (g), 2019)*

Light Sources Used in Plant Production

In many stages of crop production, the use of artificial light sources has become widespread in order to influence the physiology of yield, quality, plant growth and development. The reason for this is the increase in production diversity due to consumer demand in recent years.

In crop production, artificial light sources can be used in growing cabinets or cabinets without sunlight besides lighting support. Incandescent lamps, metal halogen lamps, fluorescent lamps, high pressure sodium vapor discharge lamps and LED lamps in recent years are widely used in vegetable production light sources (Koç et al., 2009; Anonymous, 2010; Dayioglu and Silleli 2012).

Incandescant lamps

ncandescent lamps emit light by heating the tungsten wire to approximately 2500 ° C. At this temperature, the spectrum emitted from the filament contains significant visible radiation. In incandescent lamps, 15% of the energy (watts) is emitted in PAR (400-700 nm). The remaining 75% is infrared (850-2700 nm) and 10% is thermal energy (> 2700 nm). Since the light activities and lamp life of incandescent lamps are not very high, these lamps are not a very effective source of radiation in providing additional illumination in photosynthesis. However, these lamps are relatively inexpensive to use, frequent switching cycles can be applied and generate substantially red and infrared radiation. These lamps are used for additional lighting at night and long day applications (Anonymous, 2010).

Fluorescent lamps

Unlike incandescent lamps, fluorescent lamps produce light by stimulating low-pressure mercury vapor. The high differential voltage at the electrodes at the opposite ends of the lamp tube has a stimulating effect on the mercury ion in the gas mixture and emits short wavelength (UV) radiation. The special fluorescent coatings in the glass tube convert these short wavelength rays into visible spectra. Fluorescent lamps have more efficient light production and have longer life than incandescent lamps. At the same time, these lamps heat up less and form a very stable spectrum within the PAR range. The cooler operation of fluorescent lamps allows it to be installed close to plants in climate rooms and especially in multi-storey systems (Anonymous, 2010). In a study conducted by Hamamoto and Yamazaki (2011), it was found that tomato yield increased by 10% as a result of additional lighting with fluorescent lamp in tomatoes.

Metal halide lamps

Metal halogen lamps use mercury vapor and different iodide mixtures (sodium, thorium and thallium) in the quartz arc tube. These lamps provide the best overall spectral distribution in crop production compared to other lamps. However, energy conversion in the PAR range (especially in the yellow-red spectra) is not as effective as high-pressure sodium lamps (Anonymous, 2010).

High pressure sodium discharge lamps

High pressure sodium lamps (HPS) have become the most popular lamp type used in crop production applications. The emission spectrum was concentrated in the yellow-orange-red range (500-650 nm). The blue spectrum is very low. When these lamps are used as light sources; fluorescent, mercury vapor or other light sources with high blue light may need to be supplemented (Anonymous, 2010). Nakkila et al. (2006), in a study made by HPS (400 Watt) lamps on tomato yields were investigated and the efficiency and quality of tomatoes were found to increase. Dominique-Andre et al. (1998), in a study conducted by the effects of HPS lamps were examined and found an increase in tomato yield. Eltez (1995) in a study made by tomato, pepper, eggplant and cucumber with the use of HPS lamps per seedling was found to increase the number and area of leaves.

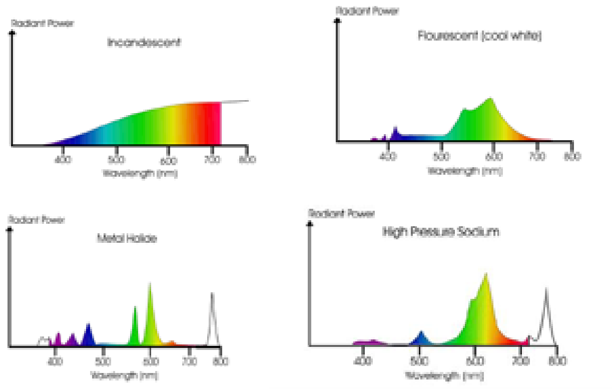


Figure 11. *Spectrum of lamps used in plant production (Anonymous, 2010)*

LED

'Light Emitting Diode ', which is known as LED semiconductor technology, can be defined as' a kind of diode '. It is essentially an electronic circuit element.

İAt first, LEDs emit only a weak red light, as well as visible light today, invisible frequency light emitting infrared (infrared, IR) or ultraviolet (ultraviolet, UV) emerged as. Knowledge of quantum physics, chemistry, electronics and optics is essential for a better understanding of the light emitting mechanism of LED.

The most important component part of the LED is the LED chip, which consists of semiconductor material and emits light. The LED chip is essentially a point light source and the reflective element located in the sheath ensures that the light is propagated in a certain direction. This orientation can also be achieved by means of lenses or reflectors used in luminaires.

The light emitted by the LEDs is related to the structure of the semiconductor additives in the LED chips. The light color emitted by an LED is determined by the addition of chemical materials such as gallium, arsenite, aluminum, phosphate, indium, nitrite to the appropriate ratio of semi-conductor material (GaAIAs, GaAs, GaAsP, GaP, InGaA-IP, SiC, GaN). This allows the LED chip to radiate at the desired wavelength.

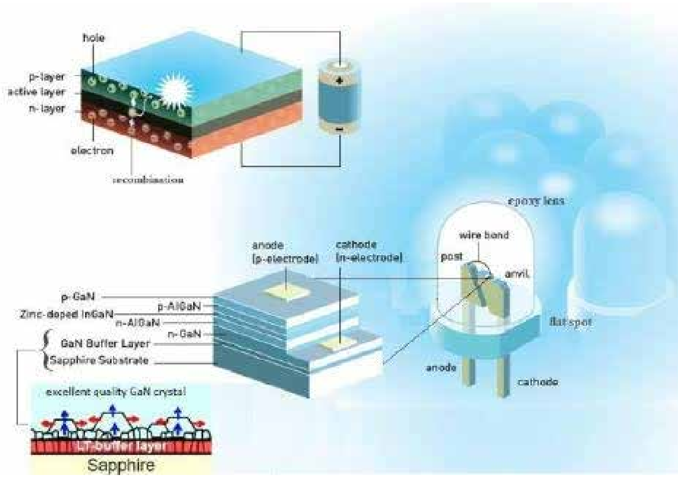


Figure 12. *Structure of the LED (Liritzis and Droseros, 2015)*

LEDs are low cost, relatively high electric-light energy conversion factor, various coloring (spectra), relatively low surface temperature, long life, gas free solid state and so on. for countless reasons.

LED in Agriculture

The implementation of LEDs for agricultural research has been extensively conducted since the 1990s. Instead of agricultural areas where fluorescent lamps were used, LEDs began to change gradually after the construction of the first LED illuminated agricultural areas in 2005 for the commercial production of green leaf plants. As of 2015, more than ten of the agricultural areas in Japan, illuminated by 200 lights, were based on LEDs. Since the 1990s, additional lighting for greenhouse plants has been replaced by high-pressure sodium lamps (HPS), which are popular in the Netherlands and North America.

Plant morphology (flowering onset, internode length, branching, rooting, etc.) and production of secondary metabolites (pigments, vitamins, etc.) are significantly affected by light quality and cycle. Therefore, LEDs with variable light quality can be used to increase the value of plants to more efficiently control morphogenesis and secondary metabolite production.

LED lightings, which have a wide range of production ranging from ultraviolet (UV) to infrared (IR) and include visible light zone, have a long service life, minimum heat generation and high light and energy efficiency (Anonymous, 2016). With LED lighting, a homogeneous radiation is created as well as significant energy savings (Özkök et al., 2016). Sase et al., Who investigated the effects of different spectral LEDs (blue, green, red and PAR-red) in additional illumination at night. (2012) found that spectral distributions for blue, green, red and PAR-red LEDs were 466, 527, 661 and 738 nm, respectively. They reported that fresh shoot weight was 22% and 38% higher in lettuce plants under blue and red light compared to control plants without additional lighting. They found that blue light promotes stem and leaf elongation. In a study conducted by Wollaeger and Runkle (2014), it was reported that the application of red LED light on ornamental plants yielded positive results. In a study by Kopsell and Sams (2013), it was reported that blue LED light increased phytochemical contents in broccoli shoots.

Köksal et al., (2013) by the light source; In the study made by using LED lamps (623nm) which gives sunlight during daylight hours and red-orange light after sunset, additional lighting made with red-orange LED light in terms of plant height, number of leaves, number of flowers and weight of biomass was put into statistical difference. Choi et al. (2015) used blue (448 nm), red (634 and 661 nm) and blue + red (= 3: 7) LED lights as the light source in strawberry plants in three different wavelength LED light applications. They found that fruit quality, growth characteristics and phytochemical production increased.

Lee et al. (2015) investigated the effects of red and blue LEDs on leaf lettuce (Lactuca sativa). Light quantities Red / Blue: 90/30, 80/40, 70/50 and 60/60 µmol $m^{-2}s^{-1}$ were mixed. As a result of the study, the highest leaf weight was obtained from 80/40 µmol $m^{-2}s^{-1}$ (47.5 g plant-1) and 90/30 µmol $m^{-2}s^{-1}$ (46.6 g plant-1) applications. In terms of leaf length, the highest values were obtained from 90/30 and 80/40 µmol $m^{-2}s^{-1}$ applications, and leaf thickness increased with the increase in the amount of blue light. Dawei et al. (2011), kırmızı red, blue, red + blue (9: 1, 8: 2, 7: 3, 6: 4, 5: 5) and fluorescent lamp applications in cucumber seedlings were tested. As a result of the study, plant growth is better in red + blue light applications; Leaf weight and chlorophyll content were the highest in Red / Blue (7: 3) application.

Xu et al. (2012), in a study conducted by the use of blue LED (450 nm) light in tomato leaves increased leaf turgor pressure, fruit color was reported to be more red and increase in yield. Hasperué et al. (2016) reported that the use of low intensity (20 mmol $m^{-2}s^{-1}$) white and blue LEDs in broccoli storage (5-22 ° C) increased chlorophyll levels. Xiao-ying et al. (2010), in the study conducted by cherry tomato seedlings white light fluorescent lamp, red + blue + yellow + green + purple LED, red + blue + green LED, red + blue + yellow LED, red + blue + purple LED, red + blue + yellow + purple LED and red + blue LED (50 mmol $m^{-2}s^{-1}$) lights. As a result of the study, the highest photosynthetic potential energy = red + blue + yellow + purple was obtained from the application. It has also been reported that the use of red + blue light and yellow and purple light alleviate low light stress in seedlings.

RESULT

The cost of artificial lighting is a major expense in the greenhouse production industry, especially in winter, when additional lighting is required to maintain production. Current technology uses broad-spectrum high-pressure sodium lamps (HPS), which are excellent light sources, but are not the most efficient light source for plant production. Special light frequencies have been shown to affect photosynthesis more directly than others (especially in red and blue ranges); Light emitting diodes (LEDs) that focus on specific wavelengths can reduce lighting costs due to their high efficiency and low operating temperatures. LEDs can be selected to target the wavelengths absorbed by plants, which allows manufacturers to customize the wavelengths of light required to maximize production and limit wavelengths that do not significantly affect plant growth.

The effects of light on plant growth and development are quite open to research. In particular, the developments in LED technology today have led to an increase in the work done. It is of great importance to present the light spectrum and its activities in more detail with the studies to be conducted in this field and to develop plant-specific light recipes.

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CHAPTER 7

EFFECTS OF ISOFLURANE/ MEDETOMIDINE ANESTHESIA ON HEART AND RESPIRATORY RATES, AND BODY TEMPERATURE IN COMMAN BUZZARD (BUTEO BUTEO)

Murat KİBAR[1]

1

INTRODUCTION

In raptors, general anesthesia can allow veterinarians to rapidly and safely apply emergency procedures, fluid administration, radiography and blood collection, or to make invasive surgical procedures (Sinn 1994, Escobar et al 2009). General anesthesia in various avian species may be produced by administration of either inhalant or parenteral injectable drugs.

Premedican techniques are employed to sedate patients to facilitate handling, contribute to the analgesia, and reduce the dosage of the anesthegic drugs (Haal et al 1999, Santos et al 2008). However, alpha-2 agonists, in spite of their powerful sedative effects in other classes of animals and the availability of effective antagonists, are not recommended as single consistent immobilization agents in birds (Santangelo et al 2009), as they also raise the risk of excitement (Pollock et al 2001, Santangelo et al 2009). Medetomidine is a preanesthetic alpha-2 agonist agent used in veterinary medicine, which induces sedation and analgesia (Atalan et al 2002, Uzun et al 2003, Uzun et al 2006).

Inhalation anesthesia has been considered the safest technique in birds due to rapid induction and recovery, simple adjustment in anesthetic depth, minimal biotransformation and myocardial depression (Ludders and Matthews 1996, Naganobu et al 2001, Gunkel 2005, Escobar et al 2009). Isoflurane is an anesthetic of choice in birds because rapid induction, rapid recovery and minimal myocardial depressant effect (Ludders et al 1989, Naganobu and Hagio 1999, Straub et al 2003). When compared to the effects of halathone, isoflurane seems to be the one that offers the greater cardiovascular stability and less airway irritation (Naganobu and hagio 1999, Escobar et al 2009, Hawkins et al 2013).

Inhalant or injectable anesthetic agents may cause severe irreversible injury to cardiovascular and respiratory systems. Despite the wide use of inhalant anesthesic agents in raptors, the efficacy of these agents is not well documented in this taxon. The purpose of this study was to investigate characteristics of induction; clinical parameters while anesthetized; and timing and quality of induction and recovery with medetomidine/isoflurane anesthesia in the young adult common buzzard (*Buteo buteo*).

MATERIAL AND METHODS

Animals

Our sample consisted of 14 common buzzards (*Buteo buteo*) (mean weight = 1.12 ± 0.06 kg; min = 0.64 kg and max = 1.70 kg) mainly young but not homogeneous for age and often of unidentified sex. The animals were under the care of the veterinary hospital, where first aid is frequently provided to this species, especially for orthopedic disorders. The birds were housed in outdoor mews and were fed with diet of day-old chicks and provided water ad libitum. All birds were untrained aviary birds. Following rehabilitation, healthy animals with only orthopedic disorders were included in study. All birds were fasted overnight prior to the study.

Anesthesia protocols

Each bird was receive of anesthetic regime: medetomidine (Tomidin, Istanbul, Turkey) 100 µg/kg and isoflurane (Forane, Istanbul, Turkey) 5% in 0.8 L/min oxygen.

In each bird physiological and physical examinations (HR, RR, BT, starts cheep in, kicking legs, lifting head and neck, and flapping wings) were performed once prior to induction and once under isoflurane/medetomidine. In isoflurane group, anesthesia was induced via face mask (4%

isoflurane in 0.8 L/min oxygen) and maintained following intubation (1.5% isoflurane in 0.8 L/min oxygen). After the first injection, each bird was confined in their boxes again and watched closely until drug had taken full effect.

Measurements

Data collected included HR, RR, BT, time to induction, time to deepest anesthesia, and time to recovery. Heart rate was calculated from electrocardiographic (ECG) records (Jalanka 1989). The ECGs were recorded by a direct writing ECG. Alligator clip electrodes were attached to skin at the base of the right and left wings and gastrocnemius muscle of the right and left limbs. Respiratory rate was determined by direct observation of the movement of the pectoral muscle (Valverde et al 1990). Body temperatures were monitored during the anesthesia and recovery periods using a cloacal probe.

HR, RR, and BT were measured before and 10 min after premedication (baseline under physical restraint) and at 5, 15, 30, 60, 120 and 360 min during anesthesia and postoperative period for all birds. The feet were taped for operator safety and the birds were placed in dorsal recumbency on a padded table and hooked to an ECG. Birds were extubed at 30th minute in isoflurane group.

The recovery time was defined as being when the animal had regained all motor and sensory functions. Motor functions were tested as full response to needle prick to legs and to the various areas of the body, a complete ability to hold its head in normal, alert position, resistance of the head and the neck by palpation against pulling and to attempt to escape from manual restrain. Palpebral and corneal reflexes and response to environmental sounds were used as tests of sensory functions.

Assesment of clinical effect of anesthesia protocols

The sedative and anesthetic effects of different protocols were assessed according to the following criteria. Satisfactory muscle relaxation was defined as the condition of no head and wing control of the birds. Stages of anesthesia; (1) Able to stand up, partly responsive to environmental objects and walks voluntarily when stimulated, (2) Unable to stand up and tend to stay in lateral recumbency. Partial response against needle prick stimuli and hardly responsive to environmental stimuli, (3) Unable to restore body posture, and hardly has foot withdrawal response to needle prick. Good muscle relaxation, (4) Deep general anesthesia; no reflexes available including pedal, palpebral and corneal. Complete closure of third eyelids. Perfect muscle relaxation. No response to any pain reflexes. Osteosynthesis operations were performed in the birds. Reflexes were monitored at intervals of 3-5 min during induction and 5-10 min until recovery.

Statistical analysis

Treatment means (HR, RR, BT, onset of anesthesia, and recovery time) were compared both with in and between groups at baseline 0 and 5, 15, 30, 60, 120, and 360 min by one-way analysis of variance (Tukey's t-test) using SPPS statistical package (Version 15.0, 2006). The data were expressed as the mean ± SEM. The significance level of all tests was set at $P < 0.05$. The study was rewieved and approved by Local Institutional and Animal Care and Ethics Committee (no:13/135).

Results

Mean injected doses of medetomidine were equivalent to 100 µg/kg (MEC = 68.62 kcal) in birds, providing a good and obvious sedation and muscular relaxation in all cases. All birds became inactive (cessation of spontaneous movement) after 10 minute following injection, implying a sedative effect of the anesthetic regimes.

Alterations in HR, RR and BT throughout the anesthesia are showed in Table 1. Respiratory rate changed but remained regular in animals. Compared to baseline values, there was a decrease for RR within 5 to 120 min for group. Compared to baseline values, there was a decrease for HR within 5 to 360 min for group. Compared to baseline values, there was a decrease for BT within 5 to 120 min for group.

Table 1: *Heart and repiratory rate and body temperature (mean ± SEM) for common buzzards (Buteo buteo) anesthetized with isoflurane/medetomidine and ketamine/medetomidine combinations. Measurement areas were compared with baseline values (time = 0) by performing t-test.*

Parameters	Time (min)	Heart rate (beats/min)	Respiration rate (breaths/min)	Body temperature (^{0}C)
		Grup I	Grup I	Grup I
Baseline value	0	248.43±24.22	48.07±4.25	40.79±0.18
Pre-medication	10	105.93±4.42^{A}	41.36±4.16	40.51±0.25
Anesthesia	5	95.43±4.68 ^{b,A}	20.14±3.35^{b}	39.96±0.28^{A}
	15	92.07±5.35^{A}	17.30±3.17^{b}	39.24±0.31^{A}
	30	81.86±3.52^{A}	17.29±2.38^{b}	37.96±0.53^{A}
	60	99.15±9.30^{A}	24.46±2.20^{b}	37.37±0.35^{A}
	120	156.77±24.03^{A}	35.69±3.71	37.64±0.63^{a,A}
	360	380.73±34.23^{a,A}	44.55±5.98	40.50±0.36^{a}

a, b: The differences between the values carrying different letter in the same row are significant (P < 0.05). A: (P < 0.05) different from baseline (time = 0) value.

The time to induction, time to deepest level, and time to recovery are summarized in Table 2, with the deepest level recorded for each birds. The anesthetic effect of the isoflurane started in 2 to 3 min (2.35 ± 0.13) and effect of the ketamine started in 4 to 12 min (6.57 ± 1.02) after injection. The time of deepest anesthesia level ranged from

4 to 7 min (5.35 ± 0.24) for group. No wing flapping and excitation occured for the any of the birds for the group. When cessation of the anaesthetic agent the birds started to become conscious position with in 50 min.

Table 2: *Time of induction, time of deepest anesthesia level, and recovery time induced by isoflurane/medetomidine and ketamine/medetomidine anesthesia in common buzzards (Buteo buteo),* [a] *Significantly (P<0.001) different between group I and II.*

		Group I
Time of Induction (min)	Mean±SX	2.35±0.13
	(Min-Max)	(2-3)
Deepest Level (min)	Mean±SX	5.35±0.24
	(Min-Max)	(4-7)
Recovery Time (min)	Mean±SX	225.0±10.20
	(Min-Max)	(172-290)

The assesment of level of anesthesia induced by isoflurane/medetomidine is summarised in the Figure 3. Five minute after isoflurane delivery, all birds had fourth-degree anesthesia. Muscle hypertonicity was no bird in isoflurane/medetomidine group.

The recovery time ranged from 172 to 290 min (225.0 ± 10.20) for group. All ECG tracings showed a sinüs rhythm with normal complexes and no evidence of arrhythmias. All animals recovered from anesthesia without any disturbances. No excitement or major unwanted effects were observed in either groups. No bird was died during the study.

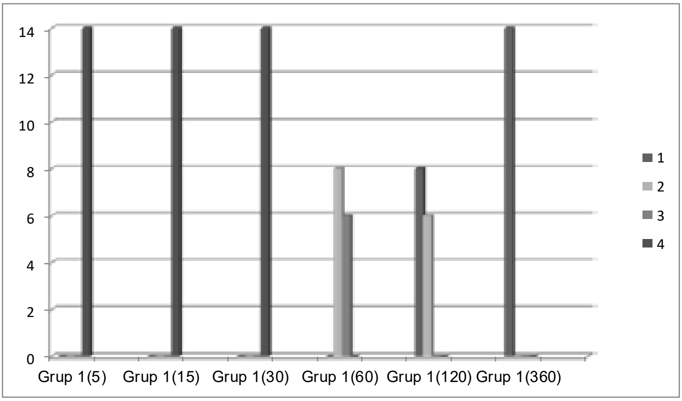

Figure 1: *Assesment of anaesthesia quality induced by isoflurane/metedomidine and ketamine/metedomidine. 1: Able to stand up, partly responsive to environmental objects and walks voluntarily when stimulated, 2: Unable to stand up and tend to stay in lateral recumbency. 3: Unable to restore body posture, and hardly has foot withdrawal response to needle prick, 4: Deep general anesthesia; no reflexes available including pedal, palpebral and corneal.*

DISCUSSION

In a study of mammals, as weight increased so did metabolic rate, but at a proportionately lower rate (Hols and Holz 1994). Therefore, larger birds should have lower metabolic rates on a per kilogram basis and require a correspondingly lower drug dose. The birds used in our study were injured and weight lost, minimal dose of isoflurane was therefore used which was less than the normal dose.

In stituations where the administration of injectable anesthetic agents is preceded by preanesthetic medication, such as opiates, agonists, ∞-2 adrenergics and phenothiazines, the induction dose can be reduced by 25 to 75% (Santos et al 2008). In the same way that dexmedetomidine was utilized in the pharmacological restraint of reptors

(Santangelo et al 2009), medetomidine in combination with ketamine can be used for the anesthesic regime in raptors.

Avian air sacs do not participate in gas exchange and the air sacs should be related to total gas volume and minute ventilation (Straub et al 2003). Only 10% of the total volume of the avian respiratory system is located in the parabronchial lungs; this is considerably smaller than in mammals in which the fractional volume of gas in the gas-exchanging airways constitutes more than 95% of the total lung volume. Thus, birds do not have a large volume of gas in their lungs that can markedly slow the rate of change of gas concentrations within the lung.

The avian lung has been shown to be a more efficient structure for gas exchange than the mammalian lung and the uptake of an inhalation anesthetic should be as fast or even faster than in mammals (Ludders et al 1989). In this study, isoflurane used at 4% concentration in 0.8 L/min oxygen for induction and general anesthesia was induced in 5 min. Anaesthesia induction by isoflurane occured rapidly and smoothly without any complication for the birds in the group. Considered a rapid gase exchange in birds, it can be deduced that inhalation anaesthesia provide a good quality of induction and recovery.

Anesthetics and sedatives possess some side effects, among which negative cardiovascular side effects are of major concern in avian species. For example, in pekin ducks anesthetized with either halothane or isoflurane, heart rate increased and there were abnormal cardiac rythyms and other ECG changes (Goelz et al 1990). It is known that among injectable anesthetics, ∞-2 adrenoreceptor agonists may produce bradycardia by depressing sympathetic activity (Uzun et al 2006). In this study, compared to baseline values, there was a decrease for HR within 5 to 360 min for group.

Heart rates of restrained, excited birds may be between 184% and 401% higher than that of caged, excitemend free birds at rest (Esconar et al 2009). Our data are similar to those found in other birds at rest, which may indicate that the animals were under minimal stress. Heart rates decreased from baseline during anesthesia. Isoflurane anesthesia was found to adversely affect cardiac function in chickens more so than either halothane or pentobarbital[1].

A decrease in HR was recorded for all birds during the anesthesia. Bradycardia is attributable to decreased sympathetic activity and enhanced vagal activity, which is a characteristic response to ∞-2 adrenoreceptor agonist, medetomidine (Dart 1999, Atalan et al 2002). The decreased HR induced in the birds of this study might be the result of medetomine administration since it has an ∞-2 adrenoreceptor agonist effect. This was, however, not the case in common buzzard (*Buteo buteo*) of present study in which HR decreased gradually preanesthetic drug. Furthermore, the bradycardia induced in the present study might be attributable to a negative chronotropic effect of the drugs on the heart.

Isoflurane produces less cardiac depression and sensitization of the myocardium to catecholamines when compared to other inhalation anesthetics such as halothane (Ludders et al 1989). In this study we used ECG and HR which is normally higher in birds than mammals (Ludders et al 1989, Pollock et al, 2001, Gunkel and Lafortune 2005, Santos et al 2008), as indices of cardiovascular function. We have not observed any cardiac arrhytmias during study.

Increasing concentrations of isoflurane cause hypoventilation in humans, dogs, cats, and horses as evidenced by concentration-dependent increases in $PaCO_2$. The relative effects of isoflurane on frequency and tidal volume depends on the species. Respiratory frequency is most depressed on the species. Respiratory frequency is most depressed in dogs and horses; in cats tidal volume is the variable most depressed[26]. In the common buzzards (*Buteo buteo*), like mammals, respiratory frequency decreased in isoflurane/medetomidine anesthesia. Medetomidine reduced the amount of isoflurane needed for maintenance of anesthesia (Zantop 1999, Santangelo 2009).

A nonrebreating circuit, such as an Ayre's T-piece, is ideal for use in birds because it offers minimal resistance to patient ventilation (Ludders and Mathews 1996, Escobar et al 2009). However, respiratory depression, induced by inhalation anesthetics, seems to be more significant in birds than in mammals. This may reflect the fact that birds rely more heavily on thoracic musculature for ventilation, and these muscles become relaxed during anesthesia (Gunkel 2005, Escobar et al 2009). In this study, compared to baseline values, there was a decrease for RR within 5 to 120 min for isoflurane/medotomidine group.

Body temperature is a reflection of the animal's metabolic rate and, hence, its demand of oxygen (Escobar et al 2009). The decreased BT gradually increased to near baseline values at 360 min in group. Fitzgerald and Cooper (1990) used heating pads to prevent hypothermia in anesthetized birds. No warming devices were used in the present study as the aim was to determine the effects of this combination on BT. We, however, advise the use of a warm air ventilator to prevent dramatic decreases in BT.

The results of this study are not similar to the study in ducks in which a medetomine, ketamine and midazolam combination produced bradycardia, respiratory depression and hypothermia (Machin and Caulkett 1998, Atalan et al 2002). In this study, RR was decreased within 5 to 120 min in birds.

In the present study, initial values were recorded under physical restraint and physiological parameters at baseline most likely differed from values that would be encountered in unrestrained common buzzards (*Buteo buteo*), and from those measured during anesthesia.

At the dosages used, anesthetic regimes produced a reliable state of surgical anesthesia. Reflexes were lost in the same order as reported by others (Hols and Holz 1994). After 5 minutes of anesthesia induction pedal, palpebral and corneal reflexes disappeared for the all birds in group. Muscle relaxation was complete in all birds. Isoflurane anaesthesia may be preferred for the painful bird surgery requiring muscle relaxation.

Muscle hypertonicity might be overcome by the administration of a premedicant agent such as an ∞-2 adrenoreceptor agonist. In this study, muscle hypertonicity was no bird in isoflurane/medetomidine group.

This current study showed that, in common buzzards (*Buteo buteo*), isoflurane/medetomidine could successfully be used to induce anesthesia without observing any disturbance such as any injury related to strulling of birds during recovery. However; there was extreme variablity in recovery time, RR, and HR, and a gradual decrease in BT that became significant in treatment group. The stastistical difference in the parameters starting from 5 min after induced anesthesia.

CONCLUSION

Isoflurane administration resulted in a satisfactory anesthesia in common buzzard (*Buteo buteo*). Analgesia and muscle relaxation of birds were adequate and no adverse side-effects were encountered. Isoflurane for anesthesia of spontaneous breathing common buzzard (*Buteo buteo*) is a reasonable choice for surgical or diagnostic procedures of moderate duration. However, isoflurane regime provided a more rapid and effective anesthesia and might be useful for the raptors requiring urgent anesthesia.

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IMPACT OF DIFFERENT CUTTING STAGES ON THE CHEMICAL COMPOSITION AND ANTIBACTERIAL ACTIVITE OF ESSENTIAL OILS FROM SALVIA OFFICINALIS L.

CHAPTER 8

Belgin COŞGE ŞENKAL[1]
Tansu USKUTOĞLU[2]

1 Yozgat Bozok University, Faculty of Agriculture, Field Crop Department, Yozgat, Turkey, belgin.senkal@yobu.edu.tr
2 Yozgat Bozok University, Faculty of Agriculture, Field Crop Department, Yozgat, Turkey,

INTRODUCTION

Essential oils obtained from various organs (leaves, flowers, bark, seeds, and roots etc.) of medicinal and aromatic plants usually are in liquid form at room temperature, and obtained using hydro distillation or different extraction methods. They are mostly colorless or light yellow in color, which can easily crystallize (Beyaz, 2014). The composition and amounts of essential oils giving plant-specific odor vary depending on the genus and organ of plant, the model of production, the geographical structure of the region in which it is grown and the climate (Angioni, Barra, Coroneo, Dessi, & Cabras, 2006; Masotti, Juteau, Bessière, & Viano, 2003). Essential oils are known to exhibit antibacterial effects on many microorganisms including Gram (-) and Gram (+) bacteria. On the other hand, since these oils are complex mixtures containing different components, their degree of action varies depending on the type and amount of chemical components they contain.

Salvia L. (or Sage) belonging to the Lamiaceae family has almost 1000 species which spread all around the world. Different *Salvia* species have been known as an important medicinal and culinary herb since ancient times. There are 99 species of *Salvia* in Turkey, and 51 of these species are endemic. *Salvia officinalis* is not a natural plant of Turkey Flora. However, the cultivation of this plant is successfully carried out in our country (Güner, Aslan, Ekim, Vural, & Babac, 2012). *S. officinalis* is perennial shrubs. Its stems are erect reaching height up to 60 cm. The flowers are violet-blue color, composed spikes. Flowering starts from March to July depending on climatic conditions. It is commonly used traditionally in tea form to treat sore throats and coughs. Economically evaluated parts of *S. officinalis* are leaves and flowers. Its leaves contain 0.5-2.5% essential oil. A high quality sage essential oil is required to have a high percentage of thujon (>50%) and a low proportion of camphor (<20%) (Baydar, 2013). *S. officinalis* essential oil has shown anti-fungal, antiviral and anti-bacterial properties. Thujone (2.5-30%), camphor (2-46%) and 1,8 cineole (2-18%) in sage essential oil are responsible for its antimicrobial activity (Kelen & Tepe, 2008; Singh, 2013). *S. officinalis* essential oil has been reported to exhibit activity against various bacteria (*Klebsiella pnömonisi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Yersinia enterocolitica*, *Shigella flexneri*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecalis*, *Salmonella* spp., *Bacillus subtilis* and *Aspergillus niger*) (Miladinović & Miladinović, 2000; Rota, Carramiñana, Burillo, & Herrera, 2004). The antimicrobial effects of essential oils obtained from medicinal and aromatic plants have a wide range of applications in various sectors such as pharmaceutical, cosmetic, perfume, agriculture and health (Raut & Karuppayil, 2014).

The aim of the present study was to investigate the effect of different cutting stages on the ratio, chemical composition and antibacterial activities of essential oils from *S. officinalis* L. cultivated in Turkey.

MATERIAL AND METHODS

Plant material

This research was carried out at experimental area of Bolu Abant İzzet Baysal University (Mudurnu, Bolu / Turkey) during 2009-2011. The seedlings were rooted in plastic cases containing perlite in 2009. These seedlings planted out in the experimental area. 60 x 40 cm plant density was used. Analysis was carried out in plants harvested in 2011. When required, irrigation and weed control was made. The soil of experimental area were clay and loam, and its water saturated total salt, pH, lime, phosphorous, potassium, and, organic matter were 51.7%, 0.09%, 7.25, 59.5%, 14.86 kg/da, 53.73 kg/da, and 1.36%, respectively. Total rainfall, mean relative humidity and temperature in 2011 were recorded as 487.0 mm, 77.0%, and 10.2 ^{o}C, respectively. Plants were harvested in three different stages as follows; the beginning of flowering (BF, on May 27), 50% of flowering (50%F, on June 22), and full flowering (FF, on August 19).

How the plant material used in the research was obtained is summarized below:

1-Cuttings were prepared from the plants in the collection parcels of the Department of Field Crops, Faculty of Agriculture, Ankara University (03.06.2009) (Figure 1).

Figure1. *Salvia officinalis L. collection parcel in Ankara University, Faculty of Agriculture, Department of Field Crops*

2-The prepared cuttings were planted in crates containing perlite and rooted (Figure 2).

Figure 2. *The cuttings prepared from Salvia officinalis L.*

3- The analyzes were carried out on the plant samples obtained in 2011 (Figure 3).

2010

2011

2012

2013

Figure 3. *Images of plants in the trial area during 2009-2011 years.*

Essential oil analysis

The aerial parts of the plants were dried in the shade at room temperature. Average 50 g of these parts ground was extracted using a Clevenger type apparatus for 3 h in 500 mL water. Essential oil values (%, v/w) were calculated by volume over dry mater. The obtained essential oils were taken into dark colored flasks and stocked at 4°C in a refrigerator until they were analyzed.

Identification of chemical components in essential oils

The chemical components of the essential oil samples from four collection times were defined by gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS) analyses. Chromatographic method for GC and GC/MS are shown in Table 1.

Table 1. *Chromatographic method*

GC instrument	Hewlett Packard 6890 N GC
Column	HP 5MS 30 m×0.25 mm×0.25 µm film thickness capillary column and FID detector
Column temperature	from 50°C to 150°C at an initial rate of 3°C/min
Injector temperature	220°C
Carrier gas	Helium
Flow rate	1 mL/min
GC/MS instrument	Hewlett Packard 5973 (mass selective detector)-6890 GC/MS system
Ionization energy	70 eV
Initial temperature	50°C
Final temperature	250 ◦C
Hold time	10 min
Rate	3°C/min
Injection	1/100 in acetone, v/v, 1.0 µL
Database	Flavor2.L, Wiley7n.1 and NIST98.L Relative percentages of the separated compounds were calculated from FID chromatograms.

Antibacterial bioassay

The disc diffusion assay (Kirby-Bauer Method) was used to screen for antibiotic activity of *S. officinalis* essential oils obtained from three different development stages. The amounts of the undiluted essential oils applied were 10 µL. The antibacterial activity test was performed as reported by Cosge et al. (2009). The microorganisms and positive controls used in this study are given Table 2.

Table 2. *The test microorganisms and positive controls used in this study*

Test microorganisms		Positive controls
Gram-negative bacteria	Gram-positive bacteria	Antimicrobial susceptibility test discs
Escherichia coli (ATCC®25922)	*Streptococcus pyogenes* (ATCC®19615)	Erythromycin (15 µg)
Pseudomonas aeruginosa (ATCC®27853)	*Staphylococcus aureus* (ATCC®25923)	Ampicillin (10 µg)
Salmonella typhimurium (ATCC®14028)	*Staphylococcus epidermidis* (ATCC®12228)	Carbenicillin (100 µg)
Serratia marcescens (ATCC®8100)		Tetracycline (30 µg)
Proteus vulgaris (ATCC®13315)		Chloramphenicol (30 µg)
Enterobacter cloacae (ATCC®23355)		
Klebsiella pneumonia (ATCC®13883)		

Bacteria evaluated within the scope of the research cause important diseases in humans. The diseases represented by the bacteria used in the study are presented in Table 3.

Table 3. *Diseases caused by bacteria used in this study (Levinson, 2014).*

Pathogen	**Diseases**
Escherichia coli	diarrhea
Pseudomonas aeruginosa	hot-tub folliculitis
Salmonella typhimurium	typhoid fever
Serratia marcescens	nosocomial infections and hospital-acquired pneumonia, urinary tract infection, and sepsis
Proteus vulgaris	urinary tract infection, and sepsis
Enterobacter cloacae	hospital-acquired pneumonia, urinary tract infection, and sepsis
Klebsiella pneumonia	pneumonia
Streptococcus pyogenes	scarlet fever
Staphylococcus aureus	food poisoning, especially vomiting, toxic shock syndrome, and scalded skin syndrome
Staphylococcus epidermidis	endocarditis, neonatal sepsis, and prosthetic hip infection

Results

Essential oil content and its components

The content and chemical components of *S. officinalis* essential oil from three different development stages were given in Table 4.

Table 4. *Essential oil content and components of S. officinalis L. at different harvest stages (%)*

Components	RT	BF	%50 F	FF
alpha-pinene	9.83	3.43	2.71	2.38
camphene	10.45	1.09	1.98	2.18
sabinene	11.34	0.36	-	-
beta-pinene	11.67	**7.01**	**4.49**	**2.56**
myrcene	12.36	1.23	0.93	1.16
alpha -terpinene	13.25	0.17	-	-
p-cymene	13.91	-	-	0.46
limonene	14.03	0.83	1.01	1.20
1,8 cineole (eucalyptol)	14.19	**6.97**	**9.00**	**5.97**
ocimene	14.54	2.07	0.78	-
gamma-terpinene	15.46	0.54	0.55	0.68
alpha-thujone	17.77	**28.46**	**36.52**	**48.94**
beta-thujone	18.23	2.41	3.45	4.16
camphor	19.54	**7.06**	**10.90**	**11.77**
isoborneol	20.53	0.70	2.71	1.35
4-carvomenthenol	21.07	0.18	-	-
borneol	26.06	-	0.74	-
beta-caryophyllene	31.78	**14.14**	**9.10**	**5.51**
valencene	32.62	0.75	0.58	0.57
alpha-humulene	33.20	**9.53**	**6.32**	**3.76**
alpha-amorphene	33.85	0.38	1.04	-
veridiflorol	38.39	3.29	-	2.49
ledene	38.63	0.65	-	-
Total		91.25	92.81	95.14
Essential oil content (%)		0.30	0.40	1.00

RT: Retention Time

The highest essential oil ratio (1.00%) was obtained from the plants harvested in the FF stage. On the other hand, the ratio of essential oil, which was 0.30% in the pre-flowering period, reached to 0.40% increased by 0.10% in the 50% flowering stage (Table 4). The rate of *S. officinalis* essential oil was recorded up to 2.4% (Damjanovic-Vratnica, Đakov, Šukovic, & Damjanovic, 2008; Golparvar et al., 2017).

The total 20, 17, and 16 components representing 91.25%, 92.81%, and 95.14% of the total essential oils were detected in the BF, 50%, and FF stages, respectively. In all essential oil samples, alpha-thujone was recorded as the highest value component. The value of this component was determined as 28.46%, 36.52% and 48.94% in BF, %50F and FF stages, respectively. Beta-caryophyllene, camphor, alpha humulene, 1,8-cineole and beta-pinene were identified as other major components. The highest values of beta-pinene, beta-caryophyllene an alpha-humulene D were recorded in the BF period. With the advancement of development, the quantity of these three components decreased. On the contrary, an increase was observed in the amount of camphor (Table 4, Figure 4).

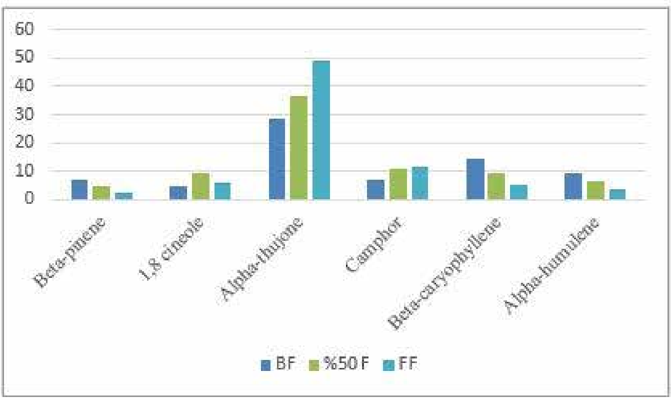


Figure 4. *Variation of the main components of essential oils according to cutting stages*

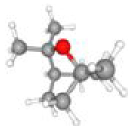
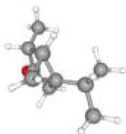
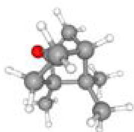
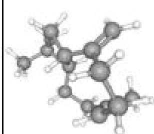
In many studies, alpha-thujone, beta-thujone and 1,8-cineole have been recorded as the dominant constituents of *S. officinalis* essential oil (Damjanovic-Vratnica et al., 2008;

Golparvar et al., 2017; Mehalaine, Belfadel, Menasria, & Messaili, 2017). In a study conducted by Khalil and Li, 2011, the predominance compounds in *S. officinalis* essential oil were recorded as 1,8-cineol, camphor, borneol, alpha-pinene, beta-pinene, camphene, beta-myrcene and caryophyllene. When the main constituents which constitute the chemical composition of *S. officinalis* essential oil are taken into consideration, our findings are consistent with other studies. In addition, *S. officinalis* essential oil has been reported to contain high levels of veridiflorol (10.93-11.71%) (Mehalaine et al., 2017; Radulescu, Chiliment, & Oprea, 2004). In our study, this component was not detected in the 50% F stage, but recorded at low rates in other stages.

In general, the chemical composition of the essential oils used in this study is in accordance with the literature data. However, the variability of chemical composition of essential oil from *S. officinalis* was generally effected by many factors, such as cultural practices (sowing time, harvesting time, fertilizing etc.), geographic location (climate and soil conditions), genotype, used parts of the plant, and extraction methods used etc. (Bhat et al., 2016; Glisic, Ivanovic, Ristic, & Skala, 2010; Laborda et al., 2013; Mehalaine et al., 2017). The uses of the main components identified in the essential oils examined in the scope of the research are summarized in Table 5. The chemical compounds identified in the research have significant potential for use in different areas.

Table 5. *The uses of the main components detected in essential oils (Anonim, 2019)**

COMPOUND	STRUCTURE	MOLECULAR FORMULA	MOLECULAR WEIGHT (g/mol)	USES
beta-pinene		$C_{10}H_{16}$	136.23	flavoring agent for ice cream, candy, baked foods odor agents air care products, cleaning and furnishing care products paper products personal care products

1,8cineole (eucalyptol)		$C_{10}H_{18}O$	154.25	fragrance and flavoring agent in foods, candies, cough drops personal care products pharmaceuticals (cough syrups, expectorants), as an expectorant, antiseptic and antibacterial, in oral care preparations perfumery odor agents
alpha-thujone		$C_{10}H_{16}O$	152.23	pesticide biocide
camphor		$C_{10}H_{16}O$	152.23	insect repellant (particularly to control clothes moths); cosmetic ingredient (depilatories, deodorant); counter-irritant disinfectants used in drinking water, or animal feed
beta-caryophyllene		$C_{15}H_{24}$	204.35	air care products
alpha-humulene		$C_{15}H_{24}$	204.35	 Usage not available

*https://pubchem.ncbi.nlm.nih.gov/compound, (Date of access: 10.11.2019)

The antibacterial activity of *S. officinalis* L. essential oil

Antibacterial activity of *S. officinalis* essential oils obtained from three different development stages were investigated in this study (Table 5).

Table 5. *Antibacterial activity of S. officinalis L. essential oils*

Mean diameter of inhibitory zones (mm)										
Stages	Gram-positive bacteria			Gram-negative bacteria						
	1	2	3	1	2	3	4	5	6	7
BF	50.3	52.3	60.7	8.3	-	9.0	15.7	22.3	9.3	9.0
50%F	40.0	54.3	40.0	14.7	-	12.3	11.3	18.3	10.3	12.3
FF	29.3	33.3	15.3	15.7	-	12.7	11.0	13.3	11.0	15.0
Chloramphenicol (30 µg)	32.0	25.0	32.6	28.2	9.0	28.0	16.8	27.0	28.8	29.2
Tetracycline (30 µg)	37.4	32.0	8.0	12.0	16.0	25.2	23.8	37.6	30.6	29.8
Ampicillin (10 µg)	48.0	40.0	31.0	20.0	-	28.0	14.0	27.0	27.0	-
Carbenicillin (100 µg)	42.8	43.8	40.0	24.4	10.0	25.2	28.0	36.8	32.0	8.0
Erythromycin (15 µg)	35.2	32.0	40.0	12.0	-	10.8	11.0	13.6	9.6	13.0

1.Streptococcus pyogenes* **2.***Staphylococcus aureus* **3.***Staphylococcus epidermidis* **(Gram +)**

1.*Escherichia coli* **2.***Pseudomonas aeruginosa* **3.***Salmonella typhimurium* **4.***Serratia marcescens* **5.Pr***oteus vulgaris* **6.***Enterobacter cloacae* **7.K***lebsiella pneumoniae* **(Gram -)**

When the efficacy of the essential oils obtained from three different development periods against the tested bacteria was examined, it was observed that the essential oils were more effective against the gram positive bacteria used. Similarly, in many studies involving antimicrobial activity, it was observed that essential oils were effective against Gram (-) bacteria than Gram (+) bacteria (Khalil & Li, 2011; Mitic-Culafic, Vukovic-Gacic, Knezevic-Vukcevic, Stankovic, & Simic, 2005; Nostro, Germanò, D'Angelo, Marino, & Cannatelli, 2000). Essential oils were ineffective against *P. aeruginosa* bacteria. Our findings are consistent with those reported by Mehalaine et al., (2017). The inhibitory effect of essential oils against Gram (+) bacteria was higher than antibiotics. This effect was observed to be higher in essential oils obtained from BF and 50% stages (Table 5).

The essential oil obtained from *S. officinalis* has a significant antimicrobial activity (Damjanovic-Vratnica et al., 2008; Mehalaine et al., 2017). Caryophyllene, alpha-pinene, borneol, 1,8-cineole, camphor, thujone and cineole are expressed as essential oil components responsible for antimicrobial activity (Dorman & Deans, 2000; Khalil & Li, 2011; Vardar-Ünlü et al., 2003). Among these compounds, thujone is toxic and its toxicity increases with concentration (Farhat, Affara, & Gali-Muhtasib, 2001). Thujone among major monoterpenes of *S. officinalis* essential oil was toxic to *Staphylococcus aureus* ATCC25923, *Staphylococcus epidermidis* ATCC12228, *Pseudomonas aeruginosa* ATCC27853, *Escherichia coli* ATCC25922, *Bacillus subtilis* ATCC10707, *Streptococcus faecalis* ATCC29212, and *Escherichia coli* IB112 and SY252 strains (Khalil & Li, 2011). Essential oils are complex mixtures containing different components, and their antibacterial effects are probably due to the synergism between many components (Khalil & Li, 2011), also minor components play an important role on antimicrobial activity (Ceylan & Fung, 2004). Similarly, in our study, although the highest thujone ratio was detected in the essential oil of the plants harvested during the FF stage, the inhibitory effect of this essential oil against bacteria, especially Gram (+) was found to be lower than that obtained from the other two stages (Table 4).

CONCLUSIONS

The different harvest stages have significant effect on percentage, chemical composition, and antibacterial activity of essential oil from *S. officinalis*. The essential oil was low in BF stage, but rapidly increasing in the other development stages. Main compounds were alpha-thujone, beta-caryophyllene, camphor, alpha humulene, eucalyptol and beta pinene. The highest value component has been alpha-thujone. The value of this component has increased from BF to FF. The essential oils investigated exhibited remarkable antibacterial activity against test bacteria except for *Pseudomonas aeruginosa*. In particular, essential oils showed very strong activity against gram positive bacteria. The effectiveness of this activity decreased as the development stages progressed.

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