

## Overview on Quail Management, Production and Its Physiological Performance (Article Review)

Lecturer \ Khalid H. Mustafa Al-Sofee<sup>1</sup>, Asst-Prof. Anwar M. Y. Al-Hamed<sup>\*1</sup>, Prof. Abdullah F. Abdul-Majeed<sup>1</sup>, Asst-Prof. Mohammad A. E. H. Osman<sup>2</sup>

<sup>1</sup> College of Agriculture and Forestry | University of Mosul | Iraq

<sup>2</sup> Faculty of Agriculture | Al-Azhar University | Egypt

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\* Corresponding author:

[dr.anwaralhamed@uomosul.edu.iq](mailto:dr.anwaralhamed@uomosul.edu.iq)

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**Abstract:** This review aims to provide information on the characteristics of quail production and management, identify its nutritional requirements, and define its role as a key component of livestock production. The quail (*Coturnix*) is known by many names in the Arabic language, and there are many types of it, each of which is divided into several varieties or subspecies. The Japanese quail (*Coturnix coturnix japonica*) is the most common and widely used in the poultry industry and scientific research. Quail, on the other hand, is a small, domesticated wild bird known for its quick, agile movements and distinctive voice. Its weight ranges from 160 to 250 grams, and it reaches sexual maturity at 5 weeks of age. It is a dual-purpose bird, producing both eggs and meat, with an annual egg production ranging from 250 to 300 eggs. Therefore, quail has significantly contributed to alleviating the meat and egg crisis in the world. In the 1960s, researchers in Japan and neighboring Asian countries focused on developing new quail breeds characterized by high body weights and high egg production when reared for 8 weeks using modern intensive rearing systems, and the Japanese quail became the most widely used in the poultry industry and scientific research because it is an important economic bird with low care costs, high egg production, rapid adaptation, and resistance to environmental conditions and diseases. It is also suitable for intensive rearing in small spaces, in addition to its short generation period (3-4 generations per year).

**Keywords:** Quail management, egg production, physiological performance, (*Coturnix japonica*), quail breeds

### نظرة عامة على إدارة وإنتاج السمان وأدائه الفسلجي (بحث مراجعة)

المدرس / خالد هادي مصطفى الصوفي<sup>1</sup>، الأستاذ المساعد / أنوار محمد يونس الحامد<sup>\*1</sup>، الأستاذ الدكتور / عبد الله فتحي عبد المجيد<sup>1</sup>، الأستاذ المساعد / محمد أحمد الصغير حسين عثمان<sup>2</sup>

<sup>1</sup> كلية الزراعة والغابات | جامعة الموصل | العراق

<sup>2</sup> كلية الزراعة | جامعة الأزهر | مصر

المستخلص: تهدف هذه المراجعة إلى تقديم معلومات حول خصائص إنتاج السمان (*Coturnix japonica*) وإدارته، وتحديد احتياجاته الغذائية، وتعريف دوره كمكون أساسي في إنتاج الثروة الحيوانية. يُعرف السمان *Coturnix* بأسماء عديدة في اللغة العربية، وهناك أنواع عديدة منه، ينقسم كل منها إلى عدة أصناف أو أنواع فرعية. يُعد السمان الياباني *Coturnix coturnix japonica* الأكثر شيوعاً واستعمالاً على نطاق واسع في صناعة الدواجن والبحث العلمي. من ناحية أخرى، فإن السمان طائر بري صغير مستأنس معروف بحركاته السريعة والرشيقة وصوته المميز. يتراوح وزنه من 160 إلى 250 غراماً، ويصل إلى مرحلة النضج الجنسي عند عمر 5 أسابيع، وهو طائر مزدوج الغرض، إذ ينتج كل من البيض واللحم، إذ يقدر إنتاجه السنوي من البيض بين 250 و300 بيضة. لذلك، ساهم السمان بشكل كبير في التخفيف من أزمة اللحوم والبيض في العالم. في ستينيات القرن الماضي ركز الباحثون في اليابان والدول الآسيوية المجاورة على تطوير سلالات جديدة من السمان تتميز بأوزان جسمية عالية وإنتاج عالي من البيض عند تربيتها لمدة 8 أسابيع باستعمال أنظمة التربية المكثفة الحديثة، وأصبح السمان الياباني الأكثر استعمالاً في صناعة الدواجن والبحث العلمي، نظراً لقيمه الاقتصادية العالية، وانخفاض تكاليف رعايته، وارتفاع إنتاجه من البيض، وسرعة تكيفه، ومقاومته للظروف البيئية والأمراض. كما أنه مناسب للتربية المكثفة في المساحات الصغيرة، بالإضافة إلى قصر مدة أجياله (3-4 أجيال سنوياً).

الكلمات المفتاحية: إدارة السمان، إنتاج البيض، الأداء الفسيولوجي، سلالات السمان.

## INTRODUCTION

The quail is a domesticated wild bird that lives in various regions of the world, and the Middle East is considered the origin of the quail, from where it began to spread to the rest of the world (Al-Badri, 2017). This is confirmed by the hieroglyphic drawings found in some Pharaonic monuments, which indicate the shape of the bird and its sacred status that this bird occupied in the era of the Pharaohs, where it was called the sacred bird and the bird of the Nile (Najm and Al-Hilali, 2017) and The use of its meat and eggs dates back to very early times in history (Farrell, 2015). The quail is a small bird, slightly larger than a pigeon; its weight varies depending on the species, ranging from 160 to 250 grams (Cahyadi *et al.*, 2019). The quail reaches sexual maturity at 5 weeks of age, depending on the duration of lighting (Lansford and Cheng, 2024). This bird has been domesticated and transformed from a wild type to a life completely controlled by humans who control its breeding, habitat, food, and reproduction. Its ancestor was domesticated in ancient China as an ornamental bird and then transferred to Japan and bred since the twelfth century AD (Lukanov and Pavlova, 2020). This breed was called the Asian or Japanese breed, and its scientific name is *Coturnix japonica* (Huss *et al.*, 2008). The Japanese quail is followed in importance by the European quail, which still lives in the wild, and millions of them migrate in the autumn towards the coasts of North Africa and West Asia via the Mediterranean Sea. This type of hunting bird breeds in various regions of the world (Abd Rabou, 2021).

At the beginning of the twentieth century, quail farming for meat and egg production spread throughout most regions of Southeast Asia. The goal of domesticating these birds was to obtain their meat and eggs (Lukanov and Pavlova, 2020). Quails are dual-purpose birds, producing both eggs and meat. On the one hand, they are prolific egg producers, with annual egg production reaching 250-300 eggs (Rodríguez-Teijeiro *et al.*, 2003; Puigcerver, 2012; Ratriyanto *et al.*, 2018). On the other hand, their growth rate is rapid due to their high metabolic rate (Vali, 2008; Abdul-Majeed *et al.*, 2013a). When studying the growth curves of quail, chicken, and turkey, it was found that the ratio of hatched chick weight to mature body weight is high in quail (Anthony *et al.*, 1991).

The female quail lays its first egg at approximately 35-42 days of age (Abdul-Majeed and Al-Krad, 2023) and reaches full sexual maturity at approximately 50 days of age (Abdul-Majeed, 2013b). Production increases sharply, reaching peak production at 12-15 weeks of age (Ratriyanto *et al.*, 2018). The best time to market quail meat, which is considered a delicious meat, is at the sixth week, but it has been observed that as the bird ages, the quality of the meat becomes more coarse and tough (Boni *et al.*, 2010).

In the 1960s, researchers in Japan and neighboring Asian countries focused on developing new breeds of these birds that boasted high body weights and high egg production when raised for 8 weeks using modern intensive breeding systems. In Japan, about 200 million quails are raised annually, in addition to being used as an experimental animal as a typical laboratory bird (Nazligul *et al.*, 2001; Huss *et al.*, 2008; Cahyadi *et al.*, 2019). It has become a prominent animal in some countries of the world due to the improvement of its production characteristics, along with other types of poultry, especially chicken, as an important source of meat and egg production (Suleiman and Muhammad, 2021).

Quail eggs are produced all over the world, but the Japanese and French markets are among the largest consumers of quail eggs (Perennou, 2009), considering that their farming provides direct nutritional benefits to the population. Quail farming projects also represent an alternative strategy for adapting to climate change in Arab countries, which reinforces the importance of improving food safety (Jeke *et al.*, 2018b).

Therefore, quail has become a distinguished economic bird for several reasons, the most important of which is that it is fast-adapting and growing, resistant to environmental conditions and diseases, and suitable for intensive rearing in a relatively small area, in addition to the short generation period (Batoool *et al.*, 2023; Ahmad *et al.*, 2018), as the hatching period of chicks ranges between 16-18 days, and it lays its first egg (i.e., reaches sexual maturity) at an age of less than 42 days (a female quail lays approximately 300 eggs annually with an average weight ranging between 10-12 grams) (Cahyadi *et al.*, 2019; Ondrusikova *et al.*, 2018).

Quail feeds on grains, seeds, fruits, and insects and can be successfully raised on concentrated feed. Thus, quail is one of the important sources of meat and egg production and has contributed significantly to reducing the meat crisis due to the interest in spreading its breeding and care (Jahan *et al.*, 2024; Akarikiya *et al.*, 2022). Its egg production is abundant, as it produces a large amount of eggs compared to the unit of body weight. The egg in a quail represents about 8% of the body weight, while we find that in chickens it represents 3%, in ducks and geese 2%, and in turkeys 1% (Tserveni-Goussi and Fortomaris, 2011).

### Scientific Classification of Quail and its Most Important Species:

The Arab region is a center of the presence and spread of quail, from where it spread to other regions of the world. It was once called the sacred bird or the bird of the Nile (Bailleul-LeSuer, 2012). Quail is classified within the animal kingdom, as stated in Huss *et al.* (2008) and Lukanov and Pavlova (2020), as follows:

Kingdom: Animalia

Phylum: Chordates

Class: Aves

Order: Galliformes

Family: Phasianidae

The Phasianidae family includes several species of birds, including pheasants, partridges, and quail.

to irrigated agriculture, providing a solution to the land problem, Second, we propose the necessity of establishing

### Types and Subspecies of Quail:

The quail is a small bird known by several names in Arabic. There are numerous species of quail, each of which is divided into several varieties or subspecies (Lukanov, 2019). Both the common quail (*Coturnix coturnix*) and the Japanese quail (*Coturnix japonica*) belong to the genus *Coturnix*.

The most important species known currently are the Japanese quail (*Coturnix coturnix japonica*), the European quail or common quail (*Coturnix coturnix*), and the bobwhite quail. It is said that the origin of the Japanese and European quail goes back to the Pharaoh quail, which arose from the mating of the Asian or Eastern quail with the European quail, so it is called the Eurasian (*Coturnix coturnix*), and it was formerly considered that the common quail is conspecific with the Japanese quail (*Coturnix japonica*). There is also the Chinese quail (*Coturnix chinensis*) (Nakamura *et al.*, 2019).

#### 1. Japanese Quail:

Its scientific name is *Coturnix coturnix japonica*. Its origins go back to Asia, specifically Japan, where it was domesticated and given the name "Japanese quail." It is widespread in Asian countries, including Iraq (Batool *et al.*, 2023). It reaches sexual maturity at 42 days of age, with an average weight of 140 grams. The mature weight reaches approximately 200–250 grams. Its generation span is short, with the hatching period ranging from 16 to 18 days (Lukanov and Pavlova, 2020). Modern breeds lay eggs prolifically, producing over 280 eggs per year. They reach 85% egg production by 10 weeks of age, and the Japanese quail has a high hatchability rate of 68–70%, similar to that of chickens (Santhi and Kalaikannan, 2017).



#### 2. White English Quail:

There are commercial strains of English quail with white feathers, which are the result of exploiting a genetic mutation called recessive white (Sayed and El Shoukary, 2021). Typically, individuals of these birds have white feathers, flecked with some gray feathers on the head and dorsal pelvis, and the chest and ventral surface are completely white, and the legs and feet are not colored (Ralph, 1979; Mizutani, 2003).



### 3. European Quail (*Coturnix coturnix*):

Its scientific name is *Coturnix coturnix*. This species resembles the Japanese quail in its phenotypic and morphological characteristics, and its life cycle is similar to it. It breeds throughout Europe (Lukanov, 2019). It is a small, pear-shaped hunting bird. It breeds in pastures and grain fields from western Europe to eastern Central Asia. It is a powerful winged flier, and it can rarely be seen in pastures (Vali, 2008). It is considered an egg-producing quail and is called a Coturnix laying quail. Females may produce 250-300 eggs per year, with an average egg weight of 10 grams, or 8% of the mother's body weight (Bagh *et al.*, 2016). Eggs are white with brown, black, blue, green, and other colored spots. There are modern quail breeds with white-shelled eggs (Ismael *et al.*, 2024).



### 4. Bobwhite Quail:

Scientifically called *Colinus virginianus*, this species differs from the Japanese and European quails in that it reaches a length of 9-10 inches and has brown-striped feathers. This species is widespread in the United States (Skewes and Wilson, 1990). Males have white feathers around the eye, while the feathers around the chest area are black-striped. Individuals reach sexual maturity at 16-20 weeks of age (Skewes and Wilson, 1990), making them later than the two previous species and modern subspecies. They lay approximately 200 eggs per year, and the incubation period ranges from 23 to 24 days. Both parents incubate the eggs, brood the hatchlings, and provide for the young until they reach independence age (Mota-Rojas *et al.*, 2023).



**genetic similarity:**

The researcher (Al-Neemy et al., 2021 ) mentioned in his study of quail species in genetic similarity derived from commonalities between different quail groups based on similarity index which is called band sharing, black quail (B1) in Mosul city showed high genetic similarity with black quail (B2) from Tikrit city where the value reached 0.9549, also he found that the highest genetic similarity was between different feather colors between black quail B1 and white quail W2 which reached 0.9391. In contrast, while the least noticeable genetic similarity was between black (B2) and white (W1) where it was 0.8468. Despite the variation in geographical location, separate breeding system and feather color, there is similarity between the breeds and this is shown in Table (1).

**Table 1. Genetic similarity values among the 6th quail groups.**

Quail groups	W1	W2	B1	B2	R1	R2
W1	1					
W2	0.9071	1				
B1	0.8571	0.9391	1			
B2	0.8468	0.8771	0.9549	1		
R1	0.8947	0.8547	0.8947	0.9026	1	
R2	0.8928	0.9217	0.9285	0.9009	0.9247	1
Average	0.8799	0.8999	0.9148	0.8964	0.8943	0.9137

While Table (2) shows the values of genetic variation among the six groups of quail studied, it was found that the lowest genetic variations were for the same color within the different flock (black quail of the two types B1 and B2), white (W1 and W2), and red (R1 and R2). A lower genetic variation was also found between groups B1 and B2. The average differences for each group with all other groups ranged between 0.1203 and 0.0851.

**Table 2. Genetic difference values among the 6th quail groups.**

Quail groups	W1	W2	B1	B2	R1	R2
W1	0					
W2	0.0929	0				
B1	0.1429	0.0609	0			
B2	0.1532	0.1229	0.0451	0		
R1	0.1053	0.1453	0.1053	0.0947	0	
R2	0.1072	0.0783	0.0715	0.0991	0.0753	0
Average	0.1203	0.1006	0.0851	0.1053	0.1057	0.0862

**Sex Determination of Quails:**

Sex can be determined at two to three weeks of age using one of the following methods:

## 1. Feather Color

The male's feathers after three weeks of age are light brown or reddish (cinnamon color) in the neck and chest area, speckled with black and not striped. There are dark brown feathers from the end of the lower beak to the back of the head (Mizutani, 2003). The female's feathers in the neck and chest area are long and pointed, lighter in color than the male's, and are speckled, striped, or mottled with gray and black (Batoool *et al.*, 2023).

## 2. Voice

The voice of an adult male quail is distinct and sharp at 5-6 weeks of age, resembling the words "Ko - turro - neex." It calls during the breeding season at night, while the female's voice is low (Nandinee and Singh, 2022).

## 3. Examination of The Cloacal Gland

To determine sex (male or female), hold the quail and turn it on its back with the palm of your hand, then examine it, as males can be distinguished from females at four weeks of age by the presence of a gland below the anus, distinguishing them from females (Homma *et al.*, 1966). This gland is called the cloacal gland or proctodeal gland (Hickman, 1984). Its size is about 1-1.5 cm<sup>3</sup>. One of the characteristics of this gland is that it is found only in males and not in females. It secretes a foamy substance similar to soap foam, which

is why it is also called a foam gland. When the male reaches sexual maturity (4 weeks), this gland appears as a swelling above the cloaca, and when pressed, a foamy substance comes out. This gland is used to evaluate the male's sexual efficiency (Homma *et al.*, 1966).

4. Size:

The female is larger and heavier than the male (Batool *et al.*, 2023).

### Fertility and Hatching:

There is no significant difference between the hatching process of quail eggs and chicken eggs, as the environmental requirements for hatching are almost identical. It has been found that the eggs of the parent flock have a significant impact on hatching rate (King' Ori, 2011). A female quail can produce more than 250 eggs in the first year of production, thus giving eggs with high fertility and a good hatching rate (Batool *et al.*, 2023). An excellent fertility rate can be obtained when the sex ratio is 2:1 (i.e., one male for every two females). Fertility continues for about 10-12 days after removing the males. However, if the males are left with the females continuously in the cages, it is possible to obtain fertilized eggs continuously. Adkins-Regan (2015) found that females can lay fertilized eggs even after being isolated from males, which the females can store the sperm for up to 11 days.

### Stages of Quail Production and Breeding:

There are successive stages in quail production, as follows:

A. The Hatching Period

1. The recommended sex ratio for breeding is 2:1 to 4:1, depending on the type of production, at a rate of 2 males to 3 females, in order to achieve excellent fertility (Lukanov and Pavlova, 2020).
2. Fertility in both sexes declines with age, beginning at 6 months of age. Therefore, it is recommended not to keep the breeding flock for more than 8 months after the start of egg production (Taghipour-Shahbandi *et al.*, 2024).
3. Placing males with females before sexual maturity helps increase the fertility rate, and fertilized eggs can be obtained starting from the third day after placing mature males with females and for a period of 6 days after separating the males from the females (Randall and Bolla, 2008).
4. Eggs are collected 2-4 times a day. Dirty, small, and poorly shelled eggs are excluded, as is the case with chicken eggs. Hatching eggs are stored at a temperature of 16-18°C and a relative humidity of 75-80% to avoid loss of the egg's water content. It is preferable that the storage period does not exceed 7 days, with the wide side of the egg facing up, to obtain a high hatching rate (Alaşahan and Bulut, 2024).
5. The incubation period of quail eggs is 16-17 days (Hanusova *et al.*, 2016). The eggs are placed in incubators from the first day at a temperature of 37.8°C and a relative humidity of 75% until the fourteenth day. Then the eggs are transferred to the hatcher trays with a temperature slightly lower than the first period, preferably around 37.4°C. The humidity must be raised to 85% in the last three days of the hatching period (Gosh and Samanta, 2008). Turning is done as in chicken eggs, i.e., 6-8 times a day from the second day of laying the eggs in the incubator. Then turning stops when the eggs are transferred to the hatcher trays on the fifteenth day (Randall and Bolla, 2008).

B. Brooding and Rearing Period

It is beneficial to raise quails in small groups, which facilitates the chicks' access to food and water during their training period. The density per unit area is: If quail chicks are raised on the floor, the stocking density reaches 150 chicks/m<sup>2</sup> in the first week of life, then gradually decreases to 100 chicks/m<sup>2</sup> at 6 weeks of age. For battery-bred quails, the stocking density reaches 250 chicks/m<sup>2</sup> in the first week of life, then decreases to 250 per 1.5 square meters in the second week of life. The density in the third week of life reaches 250 chicks per 2 square meters of cage (Ionita *et al.*, 2012).

Quail chicks are transferred to incubation halls that have been prepared according to the same specifications and requirements of incubation for chicken chicks. The hall is prepared, sterilized, and furnished with sawdust. Gas incubators are also prepared to provide the required temperature. The incubation period for quail chicks extends from the age of hatching until the age of 3-5 weeks, as the body is completely covered within 6 weeks (Batool *et al.*, 2023).

Due to the small size and weight of the chicks upon hatching, special small drinkers should be used to prevent the chicks from getting wet, which threatens their health and life, as well as to prevent them from drowning, which is better (Randall and Bolla, 2008). To avoid this, narrow-mouthed drinking troughs should be used specifically for these chicks, or plastic pieces should be placed inside the



drinking trough to prevent the chicks from entering the trough while allowing them to drink water, or fine gravel should be placed after washing and placed inside the drinking troughs at a suitable height, allowing the chicks to drink water without getting wet or drowning in the trough. After 3 weeks of age, the chicks will get used to drinking from the troughs without the need for these measures. (El-Shabrawy and Al-Rajhi, 2021).

#### C. Production Period

Sexual maturity can be defined as the age at which an animal becomes capable of reproduction (Camci *et al.*, 2002). In quails, it is approximately 42 days (six weeks) or less, at which point female birds begin to produce eggs and males become capable of producing sufficient sperm to successfully inseminate the female (Lukanov and Pavlova, 2020).

Female quail begin to produce eggs, and the production rate increases rapidly until it reaches its peak by the 12<sup>th</sup> -15<sup>th</sup> week of age, i.e., a production rate of about 90% (Ratriyanto *et al.*, 2018).

#### Breeding systems in quail projects :

There are several types of quail farming in commercial farms. Intensive farming involves raising a large number of birds per unit area using cages.

- 1- The commercial purpose is either egg or meat production. This type is used in production projects on large investment farms.



- 2- Semi-intensive farming: This type of farming uses a medium number of birds in a medium area unit. This farming is often done on the ground with partial control over the environmental field conditions. It is medium commercial production or home production. Small and medium-income breeders use this type of farming.



- 3- Traditional rearing uses a small number of birds in open or semi-open areas with less control over field conditions. This type is usually used by amateur breeders and the birds are used for personal consumption or in field experiments.



### Lighting System:

For Japanese quail to maintain optimal egg production and fertility, they require 14-18 hours of light per day. To ensure continuous production, additional lighting must be provided during the fall, winter, and spring. The lighting schedule used in quail farming varies depending on the breeding objective.

When raising birds for meat production, they should be marketed at 5-6 weeks of age, and these birds need rapid growth to reach the highest weights, so the light duration for growing young quail should be 24 hours per day for the first seven days of life, then reduced to 16 hours per day at 42 days of age. Light intensity should be maintained between 20 and 45 lux for the first seven days of chick life, then reduced to 5 lux until 42 days of age (Ionita *et al.*, 2012).

Also, quails may be raised for egg production, and the goal here will be to obtain the highest egg production. Therefore, the same lighting programs used in broiler farms or in laying hen farms can be followed. Therefore, most quail breeders for meat use a continuous lighting system throughout the rearing period, but recent studies have proven that using an intermittent lighting system is better (Gharaoghlan *et al.*, 2022).

Recent studies have shown that an intermittent lighting program with reduced light intensity has several advantages, according to Aguiar *et al.* (2017), the most important of which are:

1. Saving electricity costs and light bulb consumption.
2. Calming the flock and reducing pecking among birds, especially since quails are considered nervous and aggressive birds.
3. Improving feed conversion efficiency.

### Behavior of Quail

There are a number of behaviors that birds exhibit in interaction with their environment, including

- Eating and drinking behaviors: which begin within minutes of hatching with a few cries of grains, preferably well-ground. The birds usually eat feed in the morning, and they drink water continuously, so clean water must be available (Hassan et al., 2003).
- Motion behavior involves the movement of birds within the field. Quails are active birds that tend to move constantly. They also enjoy exploring and finding new places in their environment within the pens. Quails make sounds and exhibit flight behavior when startled.
- Social behavior: Quails live in small groups, and birds exhibit dominance and aggression among males within the group, especially in high bird densities. Males are typically more active than females and produce more and louder sounds than females (Guzmán et al., 2013).
- Rest and sleep behavior: In these birds, sleep is distributed between day and night and is primarily influenced by the lighting in the field. They also sleep on the floor, unlike chickens, which sleep on perches like chickens. They also stand on one leg when sleeping. (Mexicano et al., 2014)
- Stress Behavior: The comfortable thermal range for quail rearing is of fundamental importance, especially for long periods of time, as it affects their performance behavior (Ribeiro et al., 2016). Ventilation exacerbates or alleviates these conditions through convective cooling or heating. This interaction between birds and stressful factors is called stress behavior (Renaudeau et al., 2012). This behavior is exhibited by birds when exposed to any stressful environmental factors, such as



heat, noise, fear, overcrowding, poor ventilation, and other stressors that reduce production. Overcrowding also leads to abnormal behaviors, such as pecking and jumping suddenly in cases of fear. (Batool et al., 2023) .

- Reproductive Behavior: Females begin laying eggs at six weeks of age. However, nest building and incubation behavior differ from those of chickens. Males are active during the breeding season, vocalizing and chasing females in preparation for mating. (Arbaiza-Bayona et al., 2022)

#### Sex Ratio:

To produce fertilized eggs, adult males must be mixed with females. It has been observed that the optimal male-to-female ratio is 2:1 and up to 5:1, i.e., one male is allocated to every 2-5 females, depending on the breeding method (Jahan et al., 2024).

When raising quail in cages, the sex ratio should be between 2:1, or one male for every 2-3 females. A 5:1 ratio, or one male for every five females, is preferable (Jahan et al., 2024). When raising males and females on the ground, 70% of farmers maintain a male-to-female quail ratio on average of 1:3 to produce only fertilized eggs (Akarikiya et al., 2022).

Females continue to produce fertilized eggs for 10-11 days after the last male insemination (Adkins-Regan, 1995). This means that the female reproductive system is able to retain male sperm and its nutrition and maintain its vitality and ability to fertilize for a long period of time (Adkins-Regan, 1995).

#### Nutritional Requirements of Quail:

Nutrition plays a major role in the productive performance of quails, whether for meat or egg production. Balanced nutrition reveals the latent productive potential of genetic factors (Simeanu and Radu-Rusu, 2023). Good feed must contain fatty acids, especially oleic, linoleic, and linolenic acids, to improve feed consumption, increase the weight of the produced eggs, and improve the hatching rate (Al-Daraji et al., 2010).

Studies indicate that males can be fed the same diets given to females (Retes et al., 2019). However, ongoing studies on the nutritional requirements of quails, especially the quail's need for protein and energy, vary. Generally, they indicate that the feed for the growth stage (the first 5-6 weeks of the bird's life) contains between 20-24% protein and between 2900-3000 (kcal/kg feed) metabolized energy, while the feed for the egg production stage (after 6 weeks of age and beyond) contains between 16-20% protein and between 2700-2900 (kcal/kg feed) metabolized energy to achieve maximum productivity for quails, as detailed in the tables below. It is also noted from Table 3, which displays different studies on the protein requirements of quails compared to the protein and energy requirements of quails as specified in the N.R.C.(1994), which is 24% and energy 2500 kcal/kg, that the percentage of protein used in some studies and shown in the table ranged between 26% and 22.19%, and the energy for some studies was 3093 and decreased to 2900 kcal/kg.

**Table 3. shows the percentage of crude protein and the metabolic energy of the growing quail diet.**

References	Crude protein (%)	Metabolic energy (kcal/kg diet)
NRC, 1994	24.00	2900
Jahanian and Edriss, 2015	26.00	3000
Al-Sofee, 2018	23.32	3016
Younis and Al-Sofee, 2021 a	24.68	2927
Atallah et al., 2024	23.10	2900
Şevket et al., 2025	22.19	3093

From the table (4) it appears that the protein requirement of laying quails, as determined by the National Rural Development Organization (N.R.C, 1994), is 20%, and the specified energy ratio is 2900 kcal per kilogram of feed. There were other studies that studied the determination of the protein ratio in the feed, where the researcher (Şevket et al., 2025) stated that the protein ratio decreased to 16.88%, and despite that, it achieved the production purpose, while another study by the researcher (Abdul-Majeed, 2016) determined that he used a protein ratio of (22%). The energy, as mentioned by the researcher (Şevket et al., 2025), decreased to 2700 kcal per kilogram compared to the energy requirements according to the requirements of then.R.C., 1994)

Table 4. shows the percentage of crude protein and the metabolic energy of the laying quail diet.

References	Crude protein (%)	Metabolic energy (kcal/kg diet)
NRC, 1994	20.00	2900
Abdul-Majeed, 2016	22.00	2942
Younis and Al-Sofee, 2021 b	20.59	2919
Mariot et al., 2024	18.00	2500
Şevket et al., 2025	16.88	2701

#### Marketing Date for Quail:

Broiler quail are usually marketed at 5-6 weeks of age (Priti and Satish, 2014). We note that the birds reach their highest weight gain at the age of four weeks, and in the fifth week the weekly weight gain decreases slightly. After that, weight gain decreases gradually by the sixth week. Therefore, marketing should be done at this age or slightly before, which was recorded as a significant decrease in weight gain after the age of 7 weeks; therefore, the age of 5-6 weeks was determined as the best date for marketing quails (Taleb *et al.*, 2024).

#### Dressing Ratio and Carcass Yield:

The dressing percentage is defined as the ratio of the cleaned carcass weight of the quail to the live body weight before slaughter. In quail, the dressing percentage ranges from 60% to 80%, with an average of 75%. This percentage is considered higher than the dressing percentage of broilers at the same age (6 weeks). This percentage is affected by several factors, such as the breed, sex, age, and live weight of the birds, as well as rearing and feeding conditions (Al-Sofee, 2018). Male quails have a slightly higher dressing percentage than females (Santhi and Kalaikannan, 2017). Younger birds (6–8 weeks old) have been observed to have a higher dressing percentage than older quails (20 weeks or older) (Younis and Al-Sofee, 2021).

#### Diseases and Immunity in Quail:

In general, quails have a high resistance to disease compared to chickens. When properly cared for, Japanese quails are disease-free and do not suffer from mortality due to their good and high vitality (Farak *et al.*, 2021). Quails are not susceptible to Gumboro disease (Greenfield *et al.*, 1986), but they are susceptible to Newcastle disease and bronchial tuberculosis. They are more resistant than chickens if they are properly cared for with balanced feed and healthy environmental conditions (Greenfield *et al.*, 1986). Quails do not require multiple vaccinations or the use of antibiotics (Abao *et al.*, 2015).

#### Nutritional Value of Quail Meat:

Quail meat is considered one of the best poultry meats. It is darker in color and redder than similar white chicken meat. Quail meat has a desirable taste, is low in fat, and contains little cholesterol (Farak *et al.*, 2021). According to a report by Applegate on nutrition, quail meat is a rich and excellent source of B complex vitamins, such as vitamins B6, B2, B1, niacin, and pantothenic acid, as well as unsaturated fatty acids, phospholipids, and essential amino acids, all of which are thought to be crucial for human growth and development (Kinyua, 2022).

Among the characteristics of quail's meat, as mentioned by Farak *et al.* (2021), its body muscles are soft and tender, which make the meat distinctive, palatable, and easy to chew. Also, quail meat is characterized by its marbling (the small amount of fat present in the meat tissue distributed among its fibers), which makes quail meat have a good taste and a special flavor.

#### Quail Egg Production:

Coturnix quails reach sexual maturity at a very early age. Males are considered sexually mature when they produce their first sperm, while females are considered sexually mature when they lay their first egg. Females lay their first egg at 5-6 weeks of age (Faroq, 2014). However, females of the Bob White quail species reach sexual maturity at 20-22 weeks of age.

The daily egg cycle in female birds during the active breeding period lasts approximately 24–25 hours (Andrade *et al.*, 2023). Quails produce a large amount of eggs per unit body weight in a shorter period (Bagh *et al.*, 2016). A quail egg represents approximately 8% of a female's body weight, compared to 3% in chickens and 1% in turkeys (Bagh *et al.*, 2016; Tserveni-Goussi and Fortomaris, 2011).

Egg quality is affected by many factors, including the age of the birds, breeds, feed composition, and rearing system (Küçükylmaz *et al.*, 2012). Eggs are an essential part of the human diet, and with increasing environmental pollution, eggs are protected from environmental factors contaminated with trace elements such as iron (Fe) and copper (Cu) at high concentrations (Rolka and Wyszowski, 2020). Eggs were found to be 90% sterile, even if they were contaminated on the outer surface of the shell and internally.

Egg spoilage is caused by factors including temperature, storage period, and egg handling. Bacteria and fungi are microorganisms that contaminate eggs and increase the risk of foodborne illnesses, as these microorganisms can evade the egg's defense mechanism and then penetrate it.

Eggs are characterized by their composition of essential amino acids, an appropriate composition of unsaturated fatty acids, and an appropriate ratio of omega-6 to omega-3 fatty acids (Pingel, 2009). The biological value of eggs is 93.97%, compared to 84.55% for milk, 74.3% for beef, and 76% for fish (Rehma, 2015). chicken eggs are the most commonly consumed, but eggs from other poultry, such as quail, duck, and goose, are now used for human consumption.

Quail eggs are known for their high nutritional content. Despite their small size, the nutritional value of quail eggs is three to four times greater than that of chicken eggs (Tunsaringkarn *et al.*, 2013). Compared to chicken eggs, quail eggs have been found to contain relatively higher levels of essential amino acids, vitamins, and minerals, and are not considered harmful to individuals with egg white allergies. Furthermore, compared to chicken eggs, quail eggs have lower cholesterol and higher levels of unsaturated fatty acids (Lalwani, 2011; Sinanoglou *et al.*, 2011).

Quail eggs are characterized by their high nutritional value. Despite their small size, the nutritional value of quail eggs is three to four times greater than that of chicken eggs (Tunsaringkarn *et al.*, 2013). Compared to chicken eggs, quail eggs contain essential amino acids, vitamins (A, B complex, and E), and minerals such as phosphorus, potassium, and iron. Quail eggs also contain 5, 7.5, 6, and 15 times more phosphorus, iron, and vitamins B1 and B2, respectively. Quail eggs contain an excellent trypsin inhibitor, are heat-resistant, have stable and specific glycoproteins, and have an inhibitory effect on serine proteases, such as trypsin, by forming an enzyme-inhibitory complex. They are similar to inhaled allergens called trypsin-like proteins (Widmer, 2000). In addition, their chemical composition is harmless to people with egg white allergies. Furthermore, quail eggs contain lower cholesterol and a better ratio of unsaturated fatty acids to saturated fatty acids compared to chicken eggs (Lalwani, 2011; Sinanoglou *et al.*, 2011; Genchev, 2012). Quail eggs also have therapeutic value for many diseases, alleviating and treating them, such as ulcers, asthma, cough, obesity, diabetes, and blood pressure. According to statistics from the Food and Agriculture Organization (2015), quail egg production increased by approximately 54% between 2003 and 2012, from 7,200 to 15,858 tons.

**Table ( 5 ) comparison between quail eggs and chicken eggs of egg composition.(Ali and Abd El-Aziz, 2019).**

Type of eggs	Moisture %	Protein %	Fats %	Ash %	Carbohydrates %	Energy %	Cholesterol %
Quail Egg	72.9± 1.26	12.99±0.91	11.41±1.02	1.07±0.17	1.64±2.16	61.1±5.41	12.6±0.78
Chicken egg	74.86±2.33	11.91±1.18	10.61±2.19	0.9± 0.15	1.67 ±1.27	149.9±6.06	12.48±0.42

Tolik *et al.*, (2014) ; Tanasorn *et al.*, (2013) ; and Tunsaringkarn *et al.* (2013) reported, the content of unsaturated and polyunsaturated fatty acids : capric, myristic, palmitic, stearic, arachidic, palmitoleic, oleic, gadoleic, linolenic, linolenic, and eicosadienoic acid. However, the proportion of unsaturated fatty acids in quail eggs is relatively higher than the polyunsaturated fatty acids in chicken eggs. Polat *et al.* (2013); and Bayomy *et al.*,(2017), This was also mentioned by the researcher (Ali and Abd El-Aziz, 2019) in his study shown in Table 4. The total unsaturated acids were higher than the total saturated fatty acids and polyunsaturated fatty acids in quail eggs.

**Table (6): Fatty acids content of quail and chicken eggs**

fatty acids	Fatty acid %	
Saturated fatty acids (SFA)	Chicken egg	Quail egg

fatty acids	Fatty acid %	
Capric acid	0.27	0.18
Myristic acid	0.48	0.94
Palmitic acid	26.96	27.53
Stearic acid	9.08	5.34
Arachidic acid	0.18	0.08
Mono-unsaturated fatty acids (MUFA)		
Palmitoleic acid	4.07	4.85
Oleic acid	40.65	42.54
Gadoleic acid	0.18	0.08
Poly-unsaturated fatty acids (PUFA)		
Linoleic acid	16.33	16.61
Linolenic acid	0.82	0.65
Eicosadienoic acid	0.98	1.20
SFA %	36.97	34.07
MUFA %	44.9	47.47
PUFA %	18.13	18.46

Table (7) Egg chemical composition of some native fowls in Iraq (means  $\pm$ SE) (Al-Obaidi and Al-Shadeedi, 2017).

Component	species	protein (%)	lipids (%)	ash (%)
Yolk	Chicken	17.59 $\pm$ 0.34 <sup>c</sup>	32.41 $\pm$ 1.33 <sup>c</sup>	1.14 $\pm$ 0.11
	Mallard duck	19.42 $\pm$ 0.32 <sup>a</sup>	34.88 $\pm$ 1.36 <sup>a</sup>	1.23 $\pm$ 0.11
	Quail	17.58 $\pm$ 0.35 <sup>c</sup>	32.25 $\pm$ 1.34 <sup>c</sup>	1.21 $\pm$ 0.11
	Turkey	18.73 $\pm$ 0.32 <sup>b</sup>	33.19 $\pm$ 1.36 <sup>b</sup>	1.27 $\pm$ 0.12
Albumen	Chicken	11.76 $\pm$ 0.24 <sup>c</sup>	-	1.02 $\pm$ 0.10
	Mallard duck	12.21 $\pm$ 0.21 <sup>b</sup>	-	1.10 $\pm$ 0.10
	Quail	11.80 $\pm$ 0.21 <sup>c</sup>	-	1.05 $\pm$ 0.10
	Turkey	12.88 $\pm$ 0.22 <sup>a</sup>	-	1.12 $\pm$ 0.10

\* Significant ( $p < 0.05$ ),**Benefits of Quail Eggs:**

- Quail eggs are used in all types of egg-based dishes. They are the true taste of rural eggs. Quail eggs are used as appetite stimulants and it can be included in the diets of different age groups of males and females (Kinyua, 2022).
- Eggs are considered among the best types of bird eggs, as the ratio of yolk to white is higher than in chicken and turkey eggs, and the ratio of yolk to egg weight is the highest in quails at 30.19%, turkeys at 29.83%, and chickens at 27.52% (Sun *et al.*, 2019).
- There is a clear difference in the color and degree of spotting on the shell, which makes it difficult to examine the eggs to determine the fertility rate, as it has a white shell spotted with brown spots and different degrees of spotting, and the pigments that color the eggshell are responsible for the brown color, which are secreted on the eggshell in the uterus during the formation of the egg, and they are protoporphyrin, biliverdin, and zinc chelate, and each female quail has its own individual characteristic in producing eggs of a size, shape, and degree of spotting specific to her (Ismael *et al.*, 2024).
- The size of a quail egg is about one-fifth (1/5) of the size of a chicken egg, and the weight of a quail egg ranges between 10 and 12 grams for Japanese quail eggs (Ondrusikova *et al.*, 2018), while the average weight of Bobwhite quail eggs is 12 grams. The weight of the egg represents about 8% of the body weight of the female laying quail, while the average weight of a chicken egg is about 60 grams and represents 3% of the body weight of the hen, while in turkeys, the weight of the egg represents only 1% of the weight of the producing female (Tserveni-Goussi and Fortomaris 2011).
- The weight of the egg increases with the age of the mother (Tserveni-Goussi and Fortomaris, 2011; Camci *et al.*, 2002).

- When comparing the chemical composition of quail and chicken eggs, we can notice that the total protein content of quail eggs is higher (13.17%) than chicken eggs (12.65%), and the fat content of quail eggs (11.04%) is lower than chicken eggs (11.32%) (Tserveni-Goussi and Fortomaris, 2011).
- Quail egg yolks are characterised by their low cholesterol content compared to chicken egg yolks (Kaźmierska *et al.*, 2005).
- Quail eggs are richer than chicken eggs in calcium, phosphorus, iron, and B complex vitamins such as thiamine, riboflavin, and niacin (Nazligul *et al.*, 2001), as well as in unsaturated fatty acids (Kaźmierska *et al.*, 2005).

#### Quail Egg-Laying Cycle:

Unlike all domestic birds, female quails ovulate in the evening (afternoon), and the egg-laying process (oviposition) occurs within 24 hours, i.e., in the evening of the following day (Houdelier *et al.*, 2002; Andrade *et al.*, 2023). The female continues to lay eggs every day for several consecutive days until the egg cluster is finished, after which she stops for one day or more, then starts another egg cluster and resumes production again, and so on. The term clutch cycle or sequence refers to the number of days in which the female lays eggs daily and in a successive manner until the day of stopping or rest comes (pause day) (Ritchison, 2023).

The longer the egg-laying chain, the higher the egg production. The length of the chain is usually high at the beginning of production and reaches its peak after 4 weeks from the beginning of the production of the first egg. After that, the length of the chain decreases as the female gets older (Erensayin and Camci, 2003).

The female Japanese quail reaches its peak production rate of 92-95% and can produce 300-320 eggs during its productive year. As for the Bobwhite quail, its peak egg production rate is lower, reaching 80-85%, i.e., it produces about 200-250 eggs per year (Tserveni-Goussi and Fortomaris, 2011).

#### The Economic Importance of Quail:

Recently, interest in raising quail has increased, and special farms have been established for the breed due to its advantages, ease of care, and economic feasibility. It plays a significant role in alleviating the meat crisis, as it is a good source of animal protein, in addition to its high egg production (Okusaga, 2013).

There are numerous economic advantages to raising quail. The Japanese quail is one of the best domesticated species for meat and egg production for the following reasons:

1. Quails are adaptable to intensive poultry farming systems (Akarikiya *et al.*, 2022).
2. Quails can be raised for egg production either in cages or on the ground (Priti and Satish, 2014).
3. The life cycle of quails is very short, allowing them to produce 3-4 broods per year (Vali, 2008). They reach sexual maturity at 5-6 weeks of age (Suleiman and Muhammad, 2021).
4. A good field for investment. Quail are inexpensive to raise. They are small birds and do not require large spaces. One square meter can accommodate approximately 100 birds (Priti and Satish, 2014; Batool *et al.*, 2023); also, they can be raised year-round (Suleiman and Muhammad, 2021).
5. The cost of establishing quail farms is low compared to other poultry farms, which quail farming projects offer a rewarding return due to their rapid capital turnover, and their meat and eggs are considered distinctive foods (Adom *et al.*, 2023).
6. The incubation period for quails is short, reaching from 16 to 18 days (Akarikiya *et al.*, 2022).
7. Feeding, care, and rearing costs are lower compared to chickens due to their small size and rapid maturation, with each bird consuming approximately 500 grams of feed by the age of 42 days (Priti and Satish, 2014).
8. Quails mature sexually early (35-42 days of age), so their capital turnover is rapid when reared (Priti and Satish, 2014).
9. Their egg production is very high, with the female laying 290-300 eggs per year (Batool *et al.*, 2023).
10. Quail is a quick, cheap, and good source of animal protein, including meat and eggs (Priti and Satish, 2014).
11. Quail are resistant to many common epidemic diseases, so they do not require intensive vaccination and treatment as is the case with broilers (Vali, 2008).



## CONCLUSIONS

From the results of the current study, it can be concluded that the quail is a productive bird, whether for egg or meat production, and that its eggs and meat have numerous health benefits, in addition to the ease of caring for and raising it in the simplest fields and farms of animal production. It has also been shown that it has a significant impact on the field of economics and scientific research.

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## CONFLICT TO INTEREST

Regarding the publication of this manuscript, the authors have no conflicts of interest.

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