Mapping traditional poultry hatcheries in Egypt

AHBL • Promoting strategies for prevention and control of HPAI

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Contents

Photos

Tables

Figures

Acronyms

AGAP	Livestock Production Service Of The Animal Production And Health Division
AI vac	Inactivated Avian Influenza Vaccine
CK	Chick
CLEVB	Central Laboratory For Evaluation Of Veterinary Biologics
DHV	Duck Virus Hepatitis Virus
DK	Duck
DOB	One Day Old Birds (Either Chick Or Duckling)
DOC	Day Old Chick
DOD	One Day Old Duck
ECTAD	FAO Emergency Centre For Transboundary Animal Diseases
FAO	Food And Agriculture Organization Of The United Nations
GOVS	Egyptian General Organization Of Veterinary Services
HO	Hatchery Owner
LE	Egyptian Pound (one LE=0.185 US dollar at the period of study).
OIE	World Organization Of Animal Health
SPF	Specific Pathogen Free
TH	Traditional Hatchery
TOR	Terms Of Reference
WHO	World Health Organization

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Summary

This study was carried out in response to periodic reoccurrence of highly pathogenic avian influenza (HPAI) in Egypt, especially in backyard birds and humans and despite significant control efforts. Its objective was to develop a database of traditional hatcheries (THs) in Egypt and identifying their role in supplying genetic stock to the rural sector. A total of 84 THs were surveyed in the governorates of Gharbia (32 THs), Faiyoum (30) and Sohag (22) in July and August 2008. Nearly all the surveyed THs incubate Baladi chicken (CK) eggs, from improved breeds resulting from the crossing of native with exotic breeds, and/or pure Peking or hybrid duck (DK) eggs. About 510 000 day-old chicks (DOCs) and 192 300 day-old ducklings (DODs) were produced weekly during the study period.

There is clear seasonality in TH productivity, with high operating capacity in the winter season (January to April) along with significantly increased hatchability resulting in periods of intense rearing of growing birds. The main source of the CK eggs incubated in the surveyed THs is Qalyubia governorate (supplying 69.7 percent) followed by Faiyoum (24.3 percent) and Gharbia governorates (3.0 percent). DK eggs come from Gharbia (38.5 percent), Beheira (26.7 percent), Sharqia (14.6 percent) and Qalyubia (11.9 percent) governorates. Of the total DOCs produced, 40 percent are nursed in Faiyoum governorate, 30 percent in Sohag and 10 percent in Quena; 32 percent of the total DODs produced are nursed in Gharbia, 30 percent in Faiyoum and 13 percent in Beheira. In the surveyed THs, the hatchability percentages of both types of egg are significantly lower than those in modern hatcheries incubating the same types of egg, in both the winter and summer seasons. Hatchability decreases significantly in summer for both egg species in the THs. Weekly losses due to decreased hatchability are estimated at 66 810 DOCs and 32 499 DODs.

Regarding disease risk factors, none of the THs are organized for a one-way flow of products, workers, air and traffic from clean to dirty zones. The sun-dried mud bricks used to build most of the THs allow disinfection by fumigation only. Of the THs surveyed, about 21 percent are located within 500 m of water canals, 32 percent within 500 m of poultry farms, 75 percent within 500 m of poultry hatcheries, and 83 percent within 500 m of paved roads. About 20 percent incubate both CK and DK eggs at the same time. The turning of eggs with unprotected hands, the circulation of egg racks among THs and egg producing farms, and the lack of disinfection of the vehicles used to transport both eggs and day-old birds (DOBs) facilitate the transmission and dissemination of infectious agents across virtually all the locations involved in producing chickens and ducks. This was confirmed by the 100 percent similarity of the haemagglutinin genes of H5N1 viruses isolated simultaneously from north and south Egypt.

Arabic summary

الملخص العربى

نظراً لإستيطان مرض أنفلونزا الطيور المعدى فى مصر وتكرار حدوث الإصابة فى الطيور المنزلية كذلك الإصابات البشرية على الرغم من الجهود
المضنية المبذولة للسيطرة والتغلب على المرض، والدور الهام للمفرخات البلدية فى منظومة أنتاج الطيور البلدية , تم دراسة عدد 84 مفرخ بلدى موزعة
كلأتى 32 مفرخ فى محافظة الغربية، 30 مفرخ فى الفيوم و 22 مفرغ بمحافظة سوهاج. ووجد أن هذه المفرخات تنتج كتاكيت دجاج محسنة هى خليط من
عملية تهجين بين السلالات المحلية والأجنبية، وكذلك
تنتج بط بكينى نقى أو هجين بين البكينى والكامبل. ويبلغ أنتاج هذه المفرخات نحو نصف مليون كتكوت

دجاج عمر يوم و192 ألف بطة عمر يوم أسبوعياً أثناء فترة الدراسة فى شهرى يوليو وأغسطس عام 2008. وقد لوحظ أن أقصى طاقة أنتاجية للمفرخات
البلدية تكون فى شهور الشتاء (من يناير إلى أبريل) حيث نسبة الفقس تكون نوعياً أعلي عنها في شهور الصيف , مما يدل على ذيادة الكثافة الأنتاجية لهذه
المفرخات فى هذا الفصل. بمقارنة نسبة الفقس لذات البيض فى المفرخات البلدية بالمفرخات الحديثة، وجد أن النسبة فى الأولى أقل نوعياً من الأخرى، مما
يؤدى الي خسارة مادية بثمن عدد نحو 63.75 ألف و73.9 ألف كتكوت دجاج وبط عمر يوم على التوالى أسبوعيا أثناء فترة الدراسة.
أوضحت الدراسة أن محافظة القليوبية تعتبر المصدر الرئيسى لبيض التفريخ الدجاج البلدى للمفرخات تحت الدراسة وذلك بنسبة 69.70% تليها محافظة
الفيوم والغربية بنسبة 14.30% و3% على التوالى . بالنسبة لبيض البط تنتج الغربية 38.50% بينما محافظة البحيرة والشرقية والقليوبية تنتج 26.7 ، 14.6
، 11.9% من البيض المحضن بالمفرخات البلدية على التوالى. نحو 40% ، 30% و 10% من كتاكيت دجاج المنتج من هذه المفرخات يتم تربيتها فى
محافظات الفيوم، سوهاج و قنا على التوالى. بينما 32% ، 30% و 13% من بط عمر يوم المنتج يتم تربيته فى محافظات الغربية والفيوم والبحيرة على
التوالى.
وبدراسة عوامل مخاطر الأمراض فى المفرخات البلدية وجد أن تصميم كل هذه المفرخات لا يسمح بمرور المنتج ، العمال ، الهواء أو السيارات في أتجاه
واحد من المنطقة النظيفة (مناطق تحضين البيض) إلى الأماكن الفقس (أنتاج الكتاكيت). الطوب المصنوع من الطمى والمستخدم فى بناء معظم المفرخات لا
يسمح إلا بالتطهير عن طريق التبخير. نحو 23% ، 32% , 75% و 83 % من هذه المفرخات تقع على مسافات أقل من 500 متر من قنوات مائية ،
مزارع دواجن ، مفرخات بلدية وطرق ممهدة على التوالى. أيضا من مصادر أنتقال الأمراض, دوران أطباق البيض بين المفرخات ومزارع أنتاج البيض
المخصب، عدم الإلتزام الصريح بتطهير عربات نقل البيض أوالكتاكيت و عملية تقليب البيض بالأيدى . وعلى الرغم من النجاح الملحوظ فى أنتاج البط
والدجاج البلدى والإستمرار فى المنافسة مع المفرخات المتطورة الحديثة فإن هذه العوامل المذكورة أعلاه قد تساعد على أنتقال ليس مرض أنفلونزا
الطيورفقط ولكن باقى الأمراض الأخرى كذلك بذر هذه الأمراض فى المواقع الجغرافية المختلفة والمشاركة فى تربية هذه الأنواع من الطيور, ومما يؤكد هذا
أنه قد وجد عترات معزولة من فيروس أنفلونزا الطيور H5N1 متطابقه بنسبة 100 %. فى نفس التاريخ تقريباً من شمال وجنوب البلاد
أظهرت الدراسه أن المفرخات البلديه فى إحتياج لتحسين وتطوير التصميم وإدارة مراحل العملية الإنتاجية ليس فقط لزيادة الإنتاج و لكن تقليل فرص أنتشار
أمراض الطيور و أهمها أنفلونزا الطيور.

Introduction

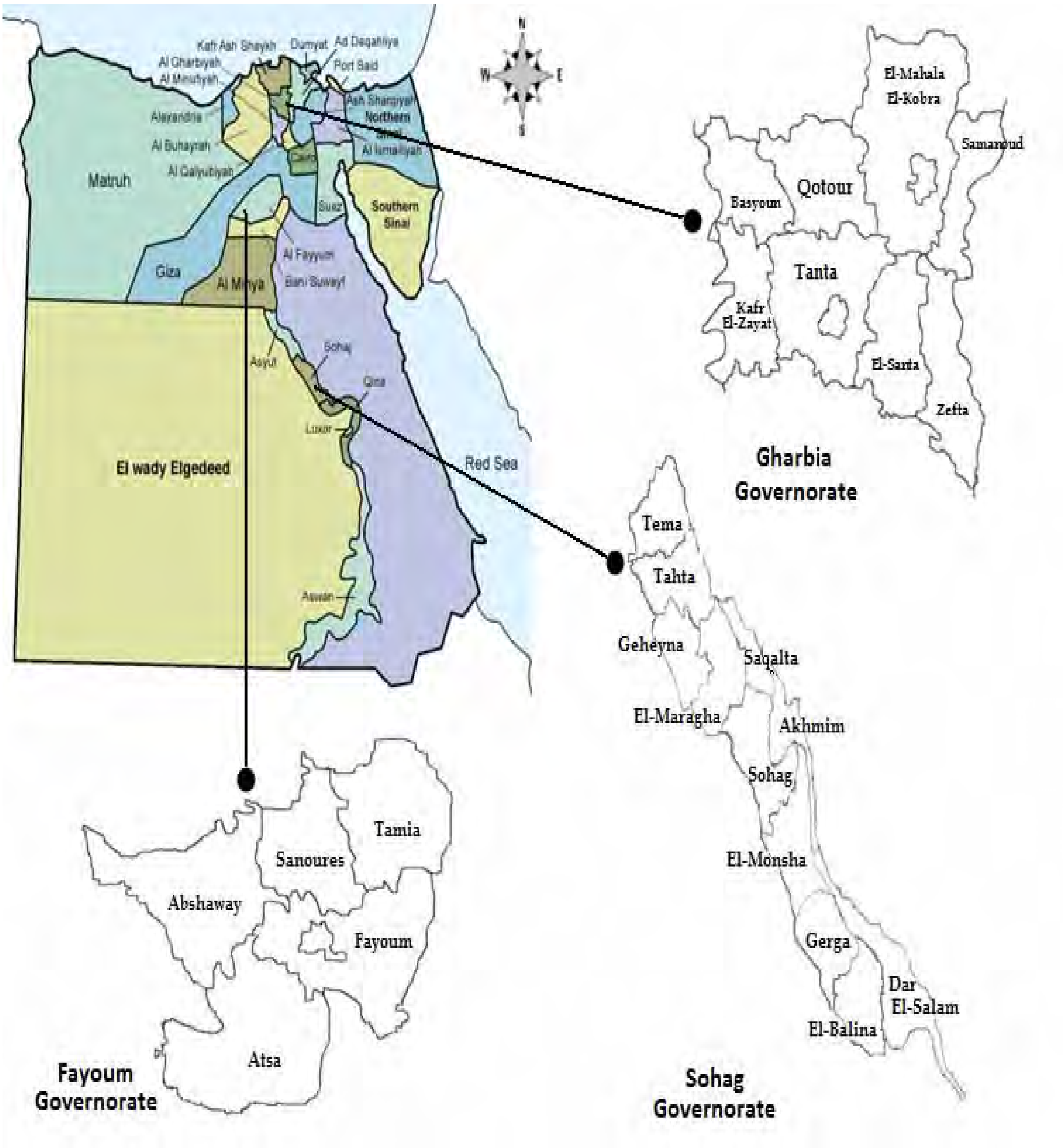
Highly pathogenic avian influenza (HPAI) subtype H5N1 is an important infection for the poultry industry in many countries. The disease was first reported in Egypt in February 2006, when at least four outbreaks in poultry were reported in different governorates. Afterwards, massive outbreaks occurred simultaneously in different governorates, with great losses to the poultry industry.

H5N1 virus is of great concern to public health because of its ability to cross species and infect humans; of 51 cases of human infection reported in Egypt, 23 were confirmed deadly (WHO, 2009). The majority of these human infections is due to direct and close contact with household poultry.

The endemic situation of HPAI H5N1 in Egypt (OIE, 2008) affects not only the commercial flocks of sectors 1, 2 and 3, but also rural households throughout most governorates.

This study aimed to develop a database of traditional hatcheries (THs) in the three Egyptian governorates of Gharbia, Faiyoum and Sohag (Figure 1), focusing on the THs' role in supplying genetic stock to the rural sector and representing central nodes in the network among egg producing farms, day-old bird (DOB) purchasers and the rural sector. The study identifies the THs' capacity, seasons of operation, types and sources of breeds, and sanitary measures during the hatching and marketing of DOBs. Its Terms of Reference (TOR) are given in Annex 1.

Figure 1 Map of Egypt with the surveyed governorates



Methodology

A seven-page questionnaire with 55 questions was designed by the national coordinator and the national consultant to identify the capacity, operating seasons, sources and types of Baladi breeds, and sanitary practices of THs in the three governorates. The questionnaire is reproduced in Annex 1.

In July and August 2008, a survey with the questionnaire was conducted at 84 THs in the three targeted governorates: 32 hatcheries in Gharbia, 30 in Faiyoum, and 22 in Sohag.

The methodology involved the participation of hatchery workers and owners to collect information about hatchery practices. Data collection allowed the exchange of technical knowledge between interviewers and hatchery workers and owners.

As well as the 84 THs, 12 commercial modern hatcheries incubating improved Baladi breeds and one government hatchery producing pure Baladi breeds were also analysed.

One specific pathogen-free (SPF) farm and two hatcheries owned by large integrated poultry companies were included as positive controls for evaluating the THs' sanitary measures.

Informal interviews were carried out with the owners of parent stock flocks producing Baladi hatching eggs (chickens and ducks), Baladi breed growers and nurseries, intermediaries and door-to-door distributors (Sarih) to gather technical information about their roles in the supply of genetic stock and the distribution of chicks and ducklings.

Data gathered from the survey were entered into a database file. SPSS analytical software version 16 (SPSS Inc.) was used to analyse the data. Simple descriptive analyses were carried out, followed by analysis of variance (ANOVA) to determine the F value and significance at $P \geq 0.05$.

The percentage contribution of each governorate as an egg producer or DOB purchaser was calculated according to the number of DOBs produced weekly by the THs at the time of data collection. The data were aggregated from the primary data.

To find the relationship among the different geographical locations involved in Baladi breed trading as egg producers, egg purchasers (THs) and DOB growers and the role of rural birds in disease transmission, a study was carried out on the genetic relationships of about 37 HPAI H5N1 viruses, selected on the basis of differences in geographical location, time of isolation and host, in addition to the two World Health Organization (WHO) recommended pre-pandemic vaccine strains. The sequences of haemagglutinin gene (surface glycoprotein) were collected from the United States National Centre for Biotechnology Information (NCBI) Influenza Virus Resource. The similarity percentage was calculated using the Blast 2 sequence (Annex 2). A multiple alignment and distance-based neighbour joining phylogenetic tree was generated using the Molecular Evolutionary Genetic Analyses (MEGA) software version 4 (Tamura et al., 2007). The accession numbers, virus names, hosts and dates of collection of selected viruses are shown in Table 1.

Table 1 Accession numbers, names, hosts, locations and times of collection of selected H5N1 isolate samples

Accession No.	Label	Isolate Name	host	Governorate	Date of collection
ABU 53974	▲	A/EGYPT/4082-NAMRU3	Human	Quena	2007
ABU 53973	▲	A/EGYPT/4081-NAMRU3	Human	Quena	2007
ABU 53975	▲	A/EGYPT/4226-NAMRU3	Human	Quena	2007
ACA 29675	▲	A/DK/EGYPT/07322 S-NLQP	DK	Menia	20/03/2007
ABP 96853	▲	A/EGYPT/2620-NAMRU3	Human	Menia	2007
ABP 96851	▲	A/EGYPT/2331-NAMRU3	Human	Aswan	2007
ACA 29676	▲	A/GOOSE/EGYPT/07364 S-NLQP	Goose	Aswan	02/04/2007
ABP 96850	(▲)	A/EGYPT/2321-NAMRU3	Human	Aswan	2007
ABP 96852	▲	A/EGYPT/2616-NAMRU3	Human	Aswan	2007
ACC 85599	●	A/CK/EGYPT/9402 NAMRU3-CLEVB 213	CK	Sharkia	3/11/2007
ACA 29671	●	A/CK/EGYPT/07201-NLQP	CK	Kaliobia	18/12/2007
ACA 29680	●	A/CK/EGYPT/07701-S-NLQP	CK	Behira	30/12/2007
ACA 29672	●	A/CK/EGYPT/07202-NLQP	CK	Quena	19/12/2007
ACI 06185	(●)	A/EGYPT/3300-NAMRU3	Human	Cairo	11/04/2008
ABO 64697	●	A/CK/EGYPT/1892-N3-HK 49	CK	Gharbia	19/02/2007
ABU 53968	■	A/EGYPT/2629-NAMRU3	Human	Sohag	2007
ABP 96854	■	A/EGYPT/2621-NAMRU3	Human	Quena	2007
ABU 53970	■	A/EGYPT/2631-NAMRU3	Human	Kaliobia	2007
ABW 37435	■	A/DK/EGYPT/R5	DK	Beni-Suef	20/02/2007
ABW 37434	■	A/GOOSE/EGYPT/R4	Goose	Beni-Suef	01/02/2007
ABP 96845	■	A/EGYPT/1394-NAMRU3	Human	Fayoum	2007
ACI 66181	■	A/EGYPT/2289-NAMRU3	Human	Fayoum	02/03/2008
ACI 66183	■	A/EGYPT/2546-NAMRU3	Human	Fayoum	08/03/2008
ABU 53969	■	A/EGYPT/2630-NAMRU3	Human	Quena	2007
ABW 37429	■	A/DK/EGYPT/F5	DK	Menia	25/12/2006
ABW 37431	■	A/CK/EGYPT/R1	CK	Beni-Suef	25/12/2006
ACA 29668	◆	A/CK/EGYPT/07120-NLQP	Quail	Alexandria	2007
ABN 70709	◆	A/CK/EGYPT/1081-NAMRU3	CK	Gharbia	2006
ACA 29669	◆	A/CK/EGYPT/07125-NLQP	CK	Behira	30/04/2007
ABO 64690	◆	A/CK/EGYPT/1889-N3-SM 26	CK	Giza	30/01/2007
ABO 64687	◆	A/CK/EGYPT/1129-N3-HK9	CK	Fayoum	22/01/2007
ABP 96846	◆	A/EGYPT/1604-NAMRU3	Human	Fayoum	2007
ABO 64688	◆	A/CK/EGYPT/123783-N3-CLEVB	CK	Gharbia	2007
ABV 24031	◆	A/EGYPT/3	CK		2006
ABU 53967	◆	A/EGYPT/2992-NAMRU3	Human	Kafr Elshiekh	2006
ABO 64691	◆	A/CK/EGYPT/1890-N3-HK 45	CK	Gharbia	18/02/2007
ACA 29670	◆	A/CK/EGYPT/07181-NLQP	CK	Fayoum	19/06/2007
ACA 29679	◆	A/CK/EGYPT/07665 S-NLQP	CK	Sharkia	2/12/2007
ABY 76247	△	A/CK/EGYPT/06207-NLQP	CK	Sharkia	19/02/2006

Findings

Overview of the traditional hatchery

In order to understand the role and efficiency and manage the risks of Egyptian traditional poultry hatcheries as producers and suppliers of DOBs for the rural sector, it is important to describe and refer to the hatchery structure, operations and workers, the eggs incubated and the management of both egg and DOB transport.

TH structure

Most THs are dome-shaped structures. The foundations are of red bricks, while the rest of the building is of sun-dried mud bricks, which assist isolation and temperature regulation. The hatchery is divided longitudinally into two sections of egg houses (or ovens) with a mid-passage (called the Qasaba) between them (Photo 1). The Qasaba floor is concrete, to facilitate cleaning and disinfection, and is covered with a layer of wood shavings where the hatched birds are left until dispatch to dry and fluff out. The shavings minimize leg deformities resulting from the birds slipping.

Photo 1 (A) Dome shaped, interior capture, (B) mid-passage in-between egg-houses.

On each side of the Qasaba, there are three to 13 egg houses, each approximately 3.5 m wide and long, and 3 m high. Each egg house (bait or oven) is divided into two levels (upper and lower units) by a wooden platform.

Photo 2 Upper unit of egg house, notice central manhole to the lower unit, feathers and egg racks.

Each unit has a separate entrance (called the Moadem), and a trap door (the Friz) between the upper and lower units that allows workers to slip from one unit to the other to set and turn the eggs (Photo 2). The floor of each unit is covered with a layer of wood shavings and either straw or a plastic carpet (called the Iasa). These protect the eggs from damage during the turning process and prevent the hatched birds from slipping.

The roof of each egg house is humped in shape with a central hole (called the Razona) for ventilation and heat regulation (Photo 3). Two or three rooms connected to the hatchery provide workers' rest rooms and storage.

Photo 3 Ventilating holes in (A) egg house, (B) mid-passage.

Recently built THs are made of red bricks, with walls lined on both sides with gypsum that act as a heat isolator; the ceilings are flat and made of wood. All other features and dimensions are the same as for older THs (Photo 4).

Photo 4 Recently built TH (hatched DOBs in Qasaba –left)

Modified or Semi-automatic hatcheries

Owing to limited financial resources and the high cost of modern hatcheries, which ranges from 200 000 to 650 000 LE for machines with capacity for 115 000 chicken (CK) eggs, some hatchery owners in Berma village, Gharbia governorate have converted the TH rest and storage rooms into egg setting and hatching units similar to those in modern hatcheries.

These rooms are made of red brick. Eggs are set on metal trolleys, each carrying about 5 000 CK eggs. Depending on the size of the room, it may contain four or more trolleys. All the eggs on one trolley are turned manually at the same time, using a metal bar (Photo 5d). Heat is generated by flaming petrol gas and temperatures are controlled by a thermostat, which activates the flaming petrol gas in suboptimal temperatures or operates a suction fan when the temperature gets too high. Relative humidity is measured by a hygrometer (photo 5B). The hatching stage takes place in a separate room, to which eggs are transferred in plastic or metal baskets three days before hatching (Photo 5c).

TH operations

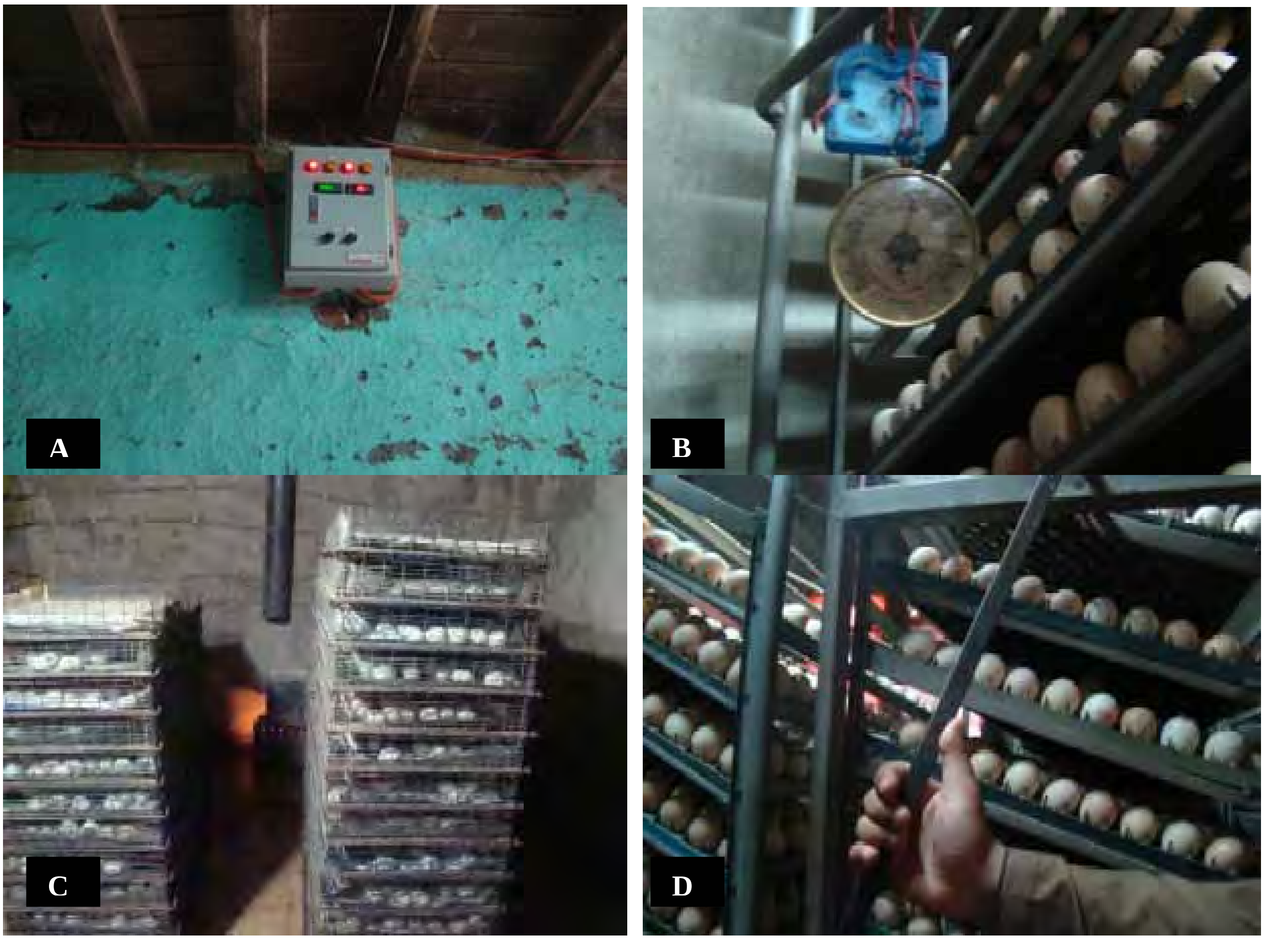
THs usually operate throughout most of the year, with a break of one to three months for rest, thorough cleaning and disinfection, usually starting in September or December.

Before starting incubation, the egg house is warmed with electric lamps, as in all the surveyed hatcheries in Sohag governorate, or petrol lamps, as in Gharbia and Faiyoum governorates. Petrol lamps are preferred in these governorates because they are cheaper to run, easier to adjust for temperature control, movable to the coldest areas inside egg houses, and not at risk from the frequent power cuts that effect the electricity supply.

Each hatchery contains eggs and birds at different stages of production, with one of its egg houses starting a new production cycle every three days or more. The capacity of each lower or upper unit is 4 000 to 5 000 CK eggs or 2 000 to 2 500 duck (DK) eggs.

Hatching of all the eggs starts in the upper unit (Photo 2) then either all are incubated in the lower unit or divided equally between both units. The units are warmed for 12 or 14 days for CK or DK eggs respectively (Photos 2 and 6D). Warming is stopped when the embryos' organs are complete and the embryos are producing enough of their own internal heat to continue the incubation process (Wilson, 2008; Berry, no date).

Photo 5 Modified or Semi hatchery (A) control unit, (B) hygrometer, (C) hatching stage, (D) egg turning.



The hatchery worker judges when the egg has reached the proper temperature by placing it in his/her eye socket (Photo 6A). Excessive egg temperature is reduced by spraying the eggs with warmed water from a perforated plastic bottle or the mouth. DK eggs of 14 days or more are routinely sprayed two to four times a day until they hatch, because they produce more internal heat than CK eggs, especially when there is an abnormal increase in the size of the air sac. No instruments are used to measure either temperature or humidity.

The eggs are turned by hand two to four times a day, until two to three days before hatching (Photo 6C). The process of candling is used to identify infertile and/or dead eggs at five to seven days of incubation, using a simple wooden box – the candler (Photo 6B) – with an electric lamp inside and a small hole in one side to emit light. Working in the dark, the hatchery worker holds each of the eggs up to the light of the candler to observe its contents.

Hatched birds are transferred to the mid-passage (Qasaba) to dry and await dispatch (Photo 1B).

Photo 6 (A) Measuring egg temperature, (B) Egg candling (C) Egg turning, (D) Warming eggs.

TH worker

In Arabic, the word for hatchery worker is Bermawy, which means “man from Berma village”. A large hatchery of at least eight egg houses needs two workers, and a smaller hatchery needs a chief worker and an assistant. Most hatchery workers have obtained no or only a low level of education.

It was noticed that all the surveyed THs in Faiyoum and Sohag governorates are operated by workers from Sanabu or Kamboha, two small villages in the Dairot district of Asyut governorate. All the hatchery workers in Gharbia are from Berma village, where skilful incubation has long been the specialty of a group of old families who mastered and guarded the techniques of their profession, passing them from one generation to the next.

TH owners

All the TH owners hope to switch to automatic incubation methods owing to the higher percentage of hatchability, better quality of DOBs and higher price for DOBs that these methods allow. Owners attributed the low hatchability of eggs and the poor quality of DOBs mainly to the low quality of eggs purchased or the carelessness of hatchery workers. Owing to their limited awareness of hygiene measures and the lack of veterinary consultancy, owners invest in expenditures that bring direct returns, rather than those whose returns are less immediate, such as disease prevention or control.

Breeds incubated by TH

None of the surveyed THs incubate geese or turkey eggs. They incubate only DK and/or Baladi CK eggs.

CKs incubated by TH

All the surveyed THs incubate the improved native breeds that have been developed since the mid-1940s from crossbreeding the native breeds Faiyoumi, Baladi, Dandarawy and Saini with the exotic breeds White Leghorn, Rhode Island Red, Plymouth and Isabrown (Hosny, 2006). Owing to the continuous and uncontrolled crossbreeding among the resultant improved breeds (Dokki 4, Mandarh, Baheig, Matrouh, El-Salam, Golden Montazh and Silver Montazh) by the producers of eggs for hatching there are no clear definitions of different types of these breeds, which are all referred to as improved Baladi or meshaarre.

CKs incubated by modern hatcheries

Most of the surveyed modern hatcheries incubate either the improved Baladi breeds that are used in egg production in the rural sector, or the first generation Shamort type used for meat production. This hybrid is a result of crossbreeding between the improved Baladi breed and exotic Sasso and/or Shaver breeds. Most first-generation CKs are raised in farms in sector 3, with a few raised in sector 2. The Shamort CK is similar in shape to the Baladi CK, but weighs 1.6 to 2 kg after about two months of fattening.

DK incubated

All traditional and modern hatcheries incubate either pure Peking ducks or a hybrid resulting from crossbreeding between Peking and Khaki Campbell. This hybrid is called Peking when the hatched ducks are white or Baladi when they are mottled with black patches. The latter is similar in shape to the native Sudani breed but has better egg production and food conversion rates. Some THs in Gharbia governorate incubate Muscovy and mallard breeds.

Transport management of Eggs and DOBs

Eggs transport

The eggs for hatching are transported at night from the parent flock farms to the hatcheries on the back of open pickup trucks. Each truck carries up to 30 000 CK or 15 000 DK eggs (Photo 8A), which are protected with a waterproof cover. The distance to the TH may be as long as 700 km or more (for example, between Qalyubia and Sohag governorates) and the journey may last more than ten hours. Inexperienced or unmotivated drivers, poorly ventilated egg trucks and rough roads may result in poorer-quality eggs for incubation. It was noticed that some egg transporting vehicles are contaminated with debris, feathers, litter shavings and faecal matter.

DOB transport

DOBs are collected in plastic baskets or boxes by unprotected hands. Each basket may carry up to 100 day-old chicks (DOCs) or 50 day-old ducklings (DODs). The baskets of DOBs are transported in open pickup trucks, protected by a water-proof cover (Photo 8B).

Photo 7 Transportation of egg (A) AND Day Old Chicks (B)

Each truck may carry up to 14 000 DOCs or 6 000 DODs. Apart from the 1 or 2 percent that may be sold directly to villagers in neighbouring houses, all the DOBs produced are transported to poultry growing or nursery farms, where CKs are raised until they weigh either 150 g (in 15 to 20 days) or 325 g (in 40 to 45 days). DKs are raised until they weigh 400 to 600, in ten to 15 days. The birds are then sold by weight to direct buyers (by a door-to-door distributor), intermediaries or traders. Door-to-door distributors usually use palm-branch crates (Photos 9A and B) or open carts (Photo 9C), and trade the birds in numbers, mainly on credit to village women, who usually choose their CKs and/or DKs on the basis of good body size, healthy appearance and colours of feather.

Photo 8 Door to door distributors.

Control hatcheries

The following observations were made during visits to the three control hatcheries used as a positive control for the study:

A hatchery sanitation plan is part of the integrated quality control system. One of the three hatcheries is certified by the International Organization for Standardization (ISO) and has well-defined standard operating procedures and working instruction programmes. There is clear implementation and control of hygiene.

- The hatchery layout considers: 1. No mixing of eggs and birds; 2. The workers' flow from the clean zone (egg setter) to the dirty zone (hatching unit), with foot dips at the entry, hand-washing facilities, showers and protective clothing facilities; 3. Positive pressure airflow in the clean zone where an air intake is near a dirty zone exhaust; the SPF farm passes the air through six filters, the last of which is a high-efficiency particulate air filter;

- All vehicles entering the hatchery pass through a disinfectant wheel wash and a vehicle spray using a disinfectant solution; the wheel wash is topped up regularly to avoid contamination and dilution; one commercial hatchery carries out a preliminary truck wash at a car-washing station 5 km from the hatchery with a special traffic film remover (Photo 10), and drivers are not allowed to leave their vehicles' cabins while in the hatchery.
- Personnel are all well-trained and qualified. The SPF farm does not allow workers to eat poultry products while on the farm to avoid infection or carrying of poultry pathogens. Workers are regularly examined for microbial infections.
- There is routine microbiological monitoring of hatchery sanitation programmes. An effective rodent control programme is in place. Hatchery waste products are properly treated before disposal.

Photo 9 Strict traffic cleaning and disinfection.


Baladi Ck and Dk movement network

There is clear seasonality in the maximum operating capacity of all surveyed THs, with the winter months of January to April having the highest hatchability, as demonstrated by the THs' intense DOB production in these months.

Field investigations with a rural distributor and a hatchery owner in Sohag governorate revealed that DOCs are more marketable than DODs in this and neighbouring governorates. CKs are preferred because they need less feed and space to raise than DKs do. It is worth noting that nearly all the DKs raised in Sohag are bought in Asyut governorate.

Overall, Qalyubia governorate is the main producer of CK eggs for THs (with 69.7 percent of the total), followed by Faiyoum (24.39 percent) (Table 2 and Figure 2). The nucleus for DK egg production is Gharbia (38.5 percent of the total), followed by Beheira (26.7 percent), Sharqia (14.6 percent) and Qalyubia (11.9 percent).

Of all the DOCs produced by the THs surveyed, 40 percent were reared in Faiyoum governorate, followed by 30 percent in Sohag and 10 percent in Quena. Of the DODs, 32 percent were reared in Gharbia, followed by 30 percent in Faiyoum and 13 percent in Beheira (Table 3 and Figure 3).

Table 2 Origin of eggs for incubation (percentage) and total weekly number of eggs hatched by the 84 selected hatcheries in three governorates

Origin	Gharbia		Faiyoum		Sohag		All	
	Ck	Dk	Ck	Dk	Ck	Dk	Ck	Dk
Gharbia	22.5	56.4	-	-	-	-	3.0	38.6
Faiyoum	-	-	61.3	10.4	-	-	24.4	3.1
Sohag	-	-	-	-	0.2	-	0.1	0.0
Beheira	16.2	29.1		22.6	-	-	2.2	26.7
Ismailia	-	-	-	5.2	-	-	-	1.6
Kafr El-Sheikh		5.0	-	-	-	-	-	3.4
Qalyubia	61.3	6.4	37.2	25.3	99.8	-	69.8	12.0
Sharqia	-	3.0	1.5	36.6	-	100.0	0.6	14.6
Number Eggs	68 000	131 500	203 000	57 800	239 000	3 000	510 000	192 300

Figure 2 The contribution of each governorate with Baladi eggs

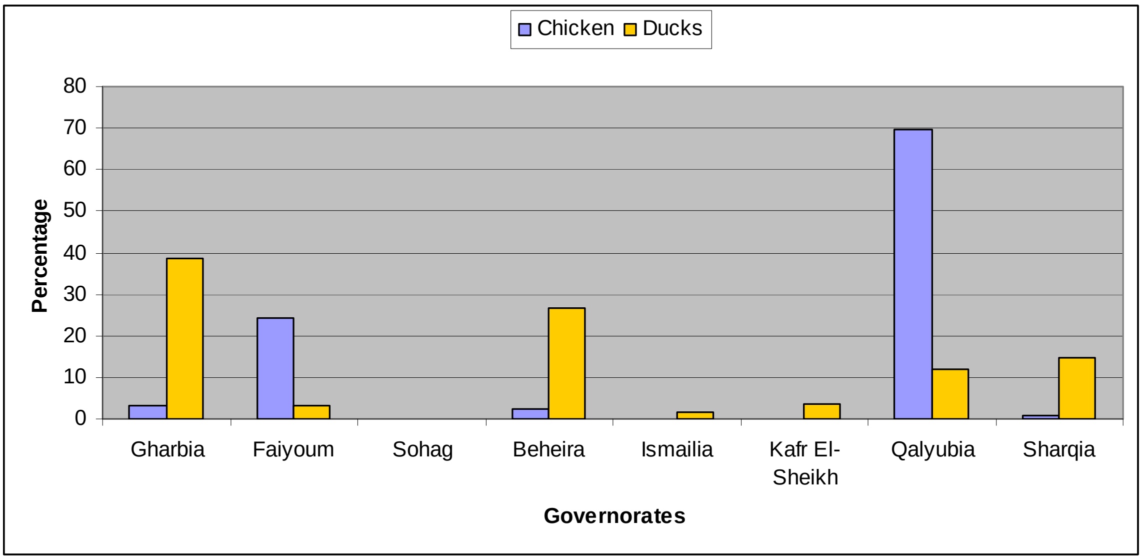
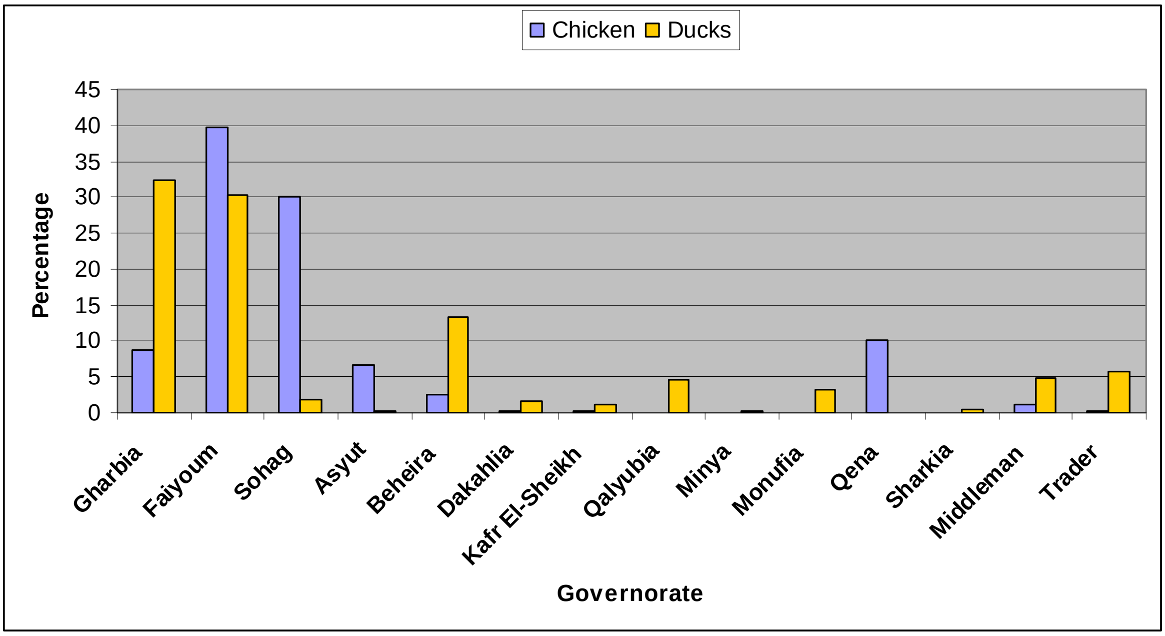


Table 3 Destination for Day Old Birds (percentage) and total weekly number of DOB distributed by the 84 selected hatcheries in three governorates

Destination	Gharbia		Faiyoum		Sohag		All	
	Ck	Dk	Ck	Dk	Ck	Dk	Ck	Dk
Gharbia	66.2	47.2	-	-	-	-	8.8	32.3
Faiyoum	-	0.5	100	100	-	-	39.8	30.4
Sohag	-	0.5	-	-	64.1	100	30.1	1.9
Asyut	-	0.5	-	-	14.2		6.7	0.3
Beheira	18.5	19.6	-	-	-	-	2.5	13.4
Dakahlia	2.1	2.1	-	-	-	-	0.3	1.5
Kafr El-Sheikh	2.1	1.8	-	-	-	-	0.3	1.2
Qalyubia	-	6.5	-	-	-	-	-	4.5
Minya	-	0.5	-	-	-	-	-	0.3
Monufia	-	4.7	-	-	-	-	-	3.2
Qena	-	-	-	-	21.7	-	10.1	-
Sharkia	-	0.8	-	-	-	-		0.5
Middleman	9.1	7.0	-	-	-	-	1.2	4.8
Trader	2.1	8.4	-	-	-	-	0.3	5.8
Number DOB	68 000	131 500	203 000	57 800	239 000	3 000	510 000	192 300

Figure 3 The contribution of each governorate purchasing DOB



Gharbia governorate THs

The 32 THs surveyed in Gharbia governorate (Figure 4) produced during data collection in July and August 2008 about 68 000 DOCs and 131 500 DODs a week. In order of importance, they depend on Qalyubia, Gharbia and Beheira governorates as sources of CK eggs, and on Gharbia, Beheira, Qalyubia and Kafr El-Sheikh for DK eggs (Figure 5). The purchasers of DOBs are located in 11 governorates, and intermediaries and traders also come to the TH locations to purchase (Figure 5).

Total number of surveyed TH incubating different egg species (Capacity of thousands)

CK			MIXING			DK		
NO.	Symbol	Capacity	NO.	Symbol	Capacity	NO.	Symbol	Capacity
1	★ (orange)	40-60	1	■ (orange)	30-40	11	▲ (orange)	20-30
1	★ (dark green)	61-80	0	■ (dark green)	41-60	12	▲ (dark green)	31-40
1	★ (blue)	81-100	2	■ (blue)	61-80	0	▲ (blue)	41-60
0	★ (green)	101-120	2	■ (green)	81-100	1	▲ (green)	61-80
0	★ (magenta)	121-180	0	■ (magenta)	101-120	0	▲ (magenta)	81-100
0	★ (light blue)	181-240	0	■ (light blue)	121-160	0	▲ (light blue)	101-120

Figure 4 Surveyed 32 THs in Gharbia governorate.

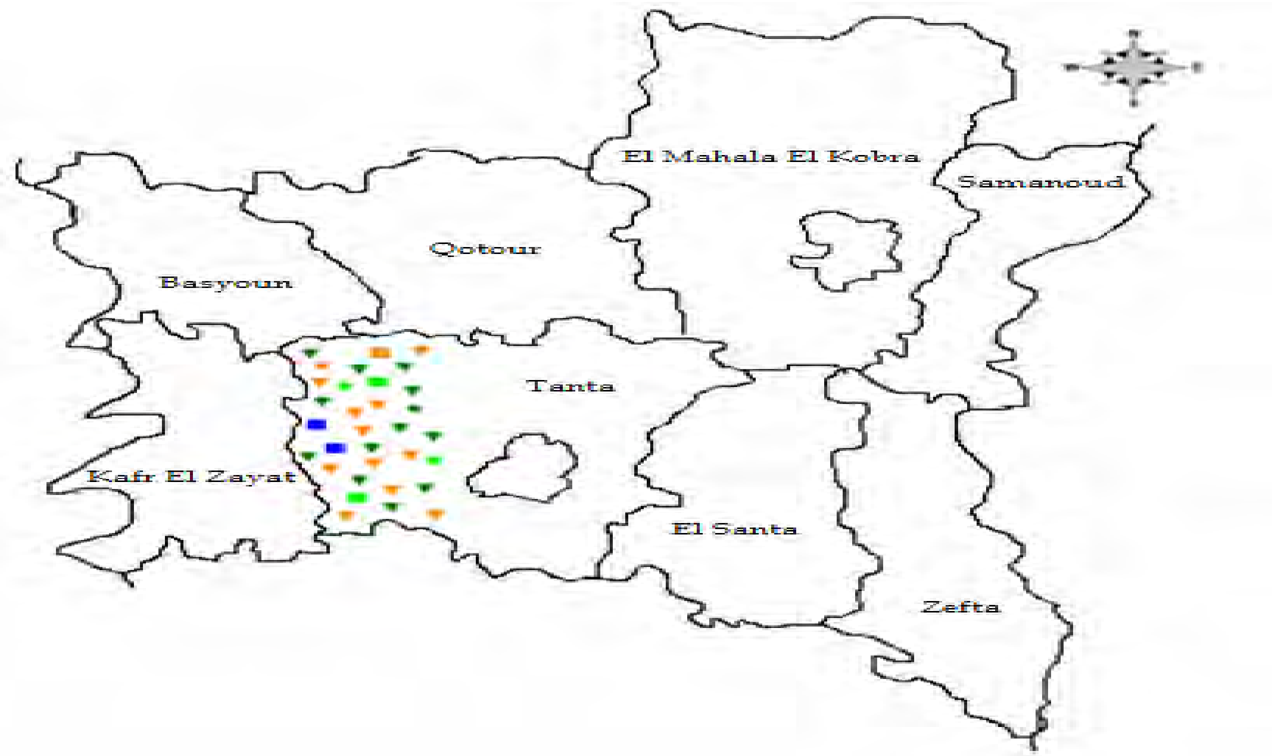
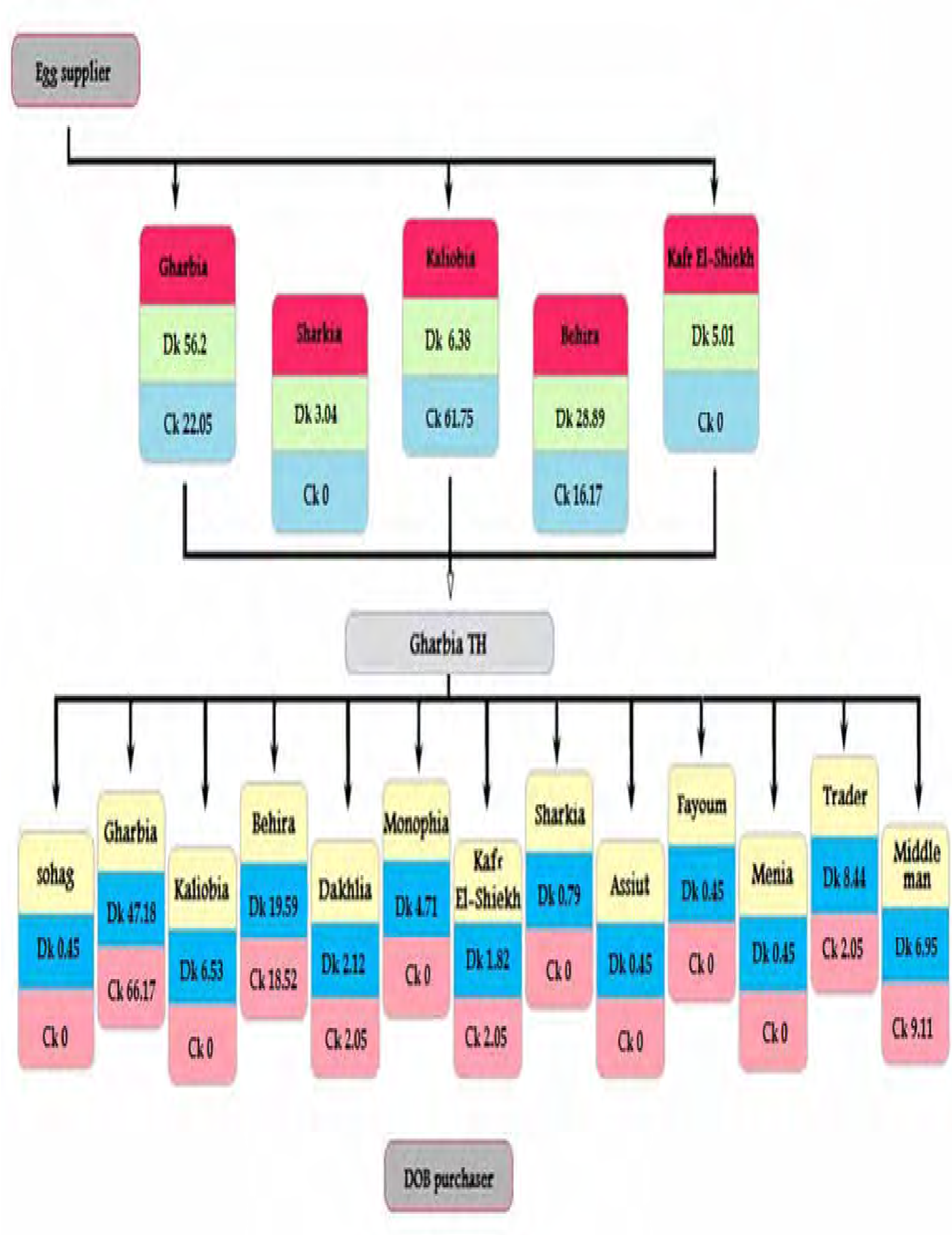


Figure 5 Locations of egg suppliers to and DOB purchaser from Gharbia THS



Fayoum governorate THs

The 30 THs surveyed in Faiyoum governorate (Figure 6) produced about 203 000 DOCs and 57 800 DODs a week in July and August 2008. They depend mainly on farms in Faiyoum as a source of Baladi CK eggs, followed by those in Qalyubia. Most duck eggs come from Sharqia and Qalyubia. Nearly all the DOBs are sold in Faiyoum (Figure 7).

Total number of surveyed TH incubating different egg species (in thousands)

CK			MIXING			DK		
NO.	Symbol	Capacity	NO.	Symbol	Capacity	NO.	Symbol	Capacity
6	★	40-60	1	■	30-40	4	▲	20-30
5	★	61-80	2	■	41-60	1	▲	31-40
3	★	81-100	2	■	61-80	0	▲	41-60
0	★	101-120	4	■	81-100	0	▲	61-80
2	★	121-180	2	■	101-120	0	▲	81-100
0	★	181-240	0	■	121-160	0	▲	101-120

Figure 6 Surveyed 30 THs in Fayoum governorate.

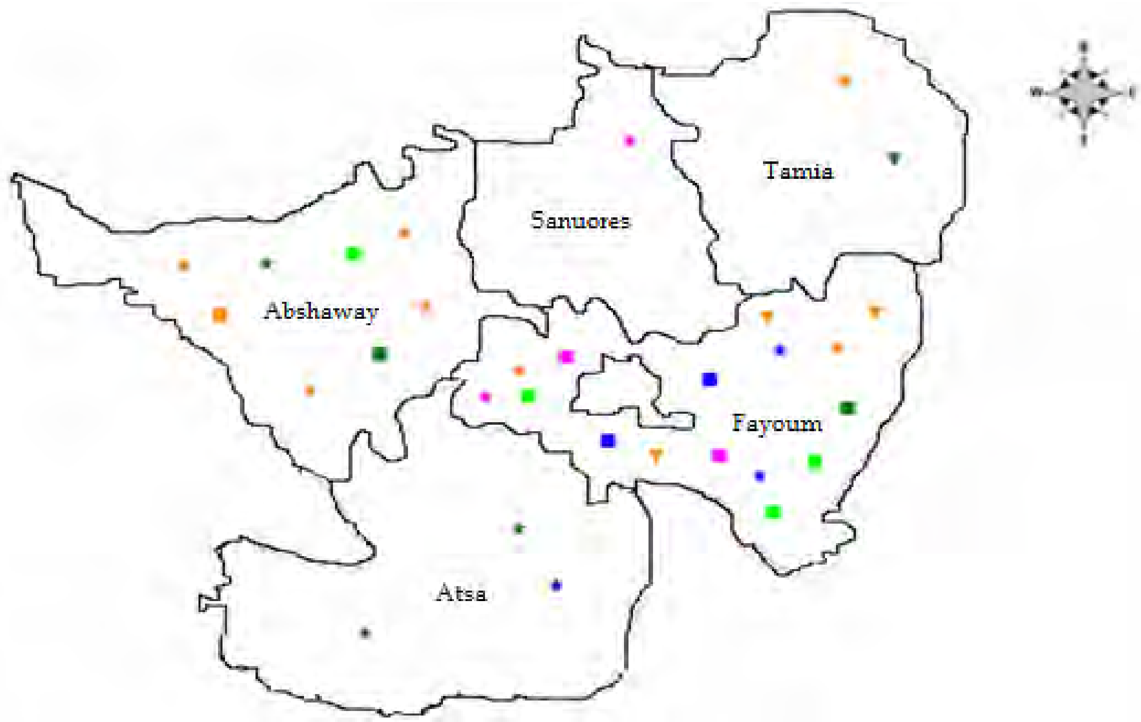
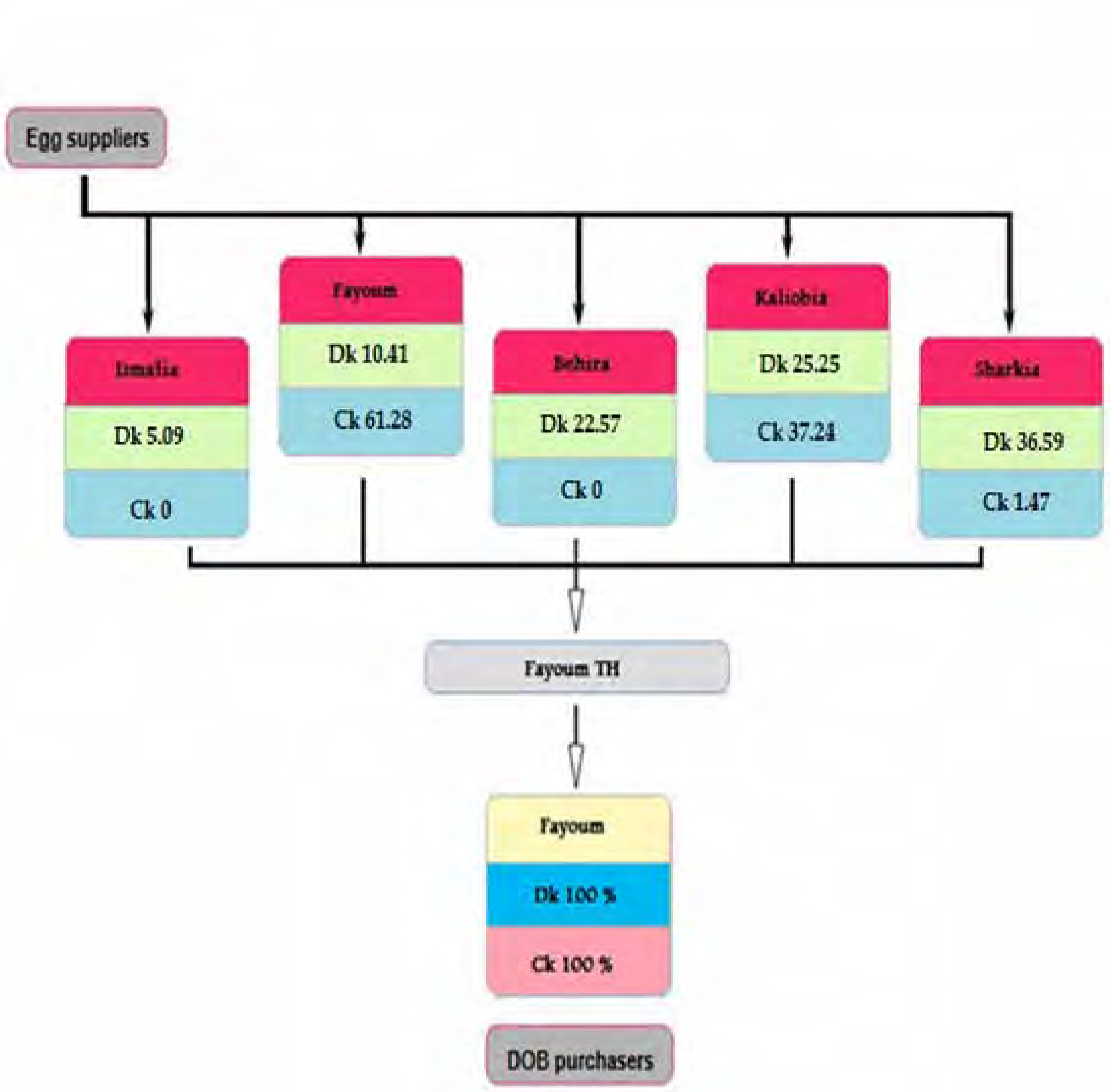


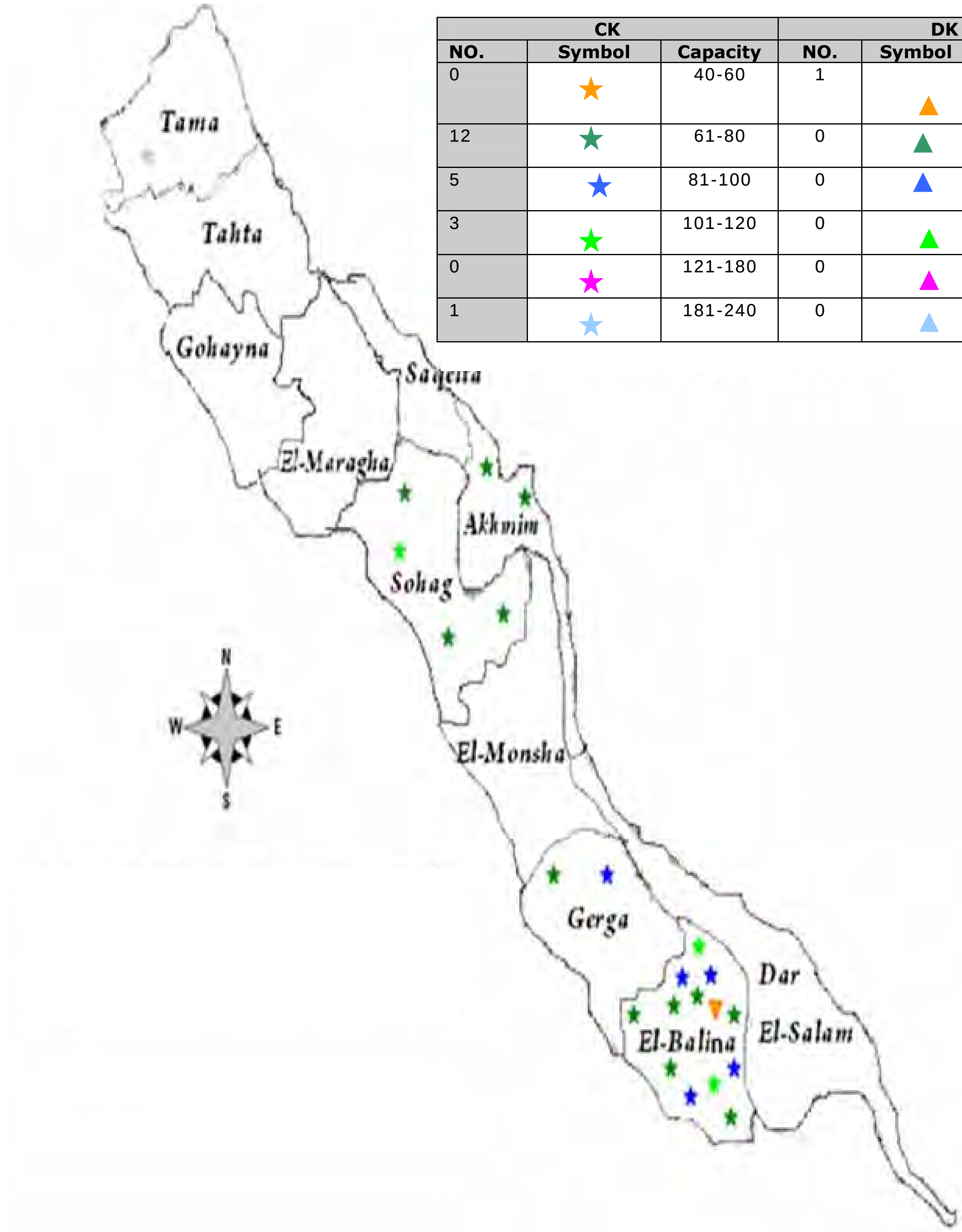
Figure 7 Locations of egg supplier to and DOB purchaser from Fayoum THs



Sohag governorate THs

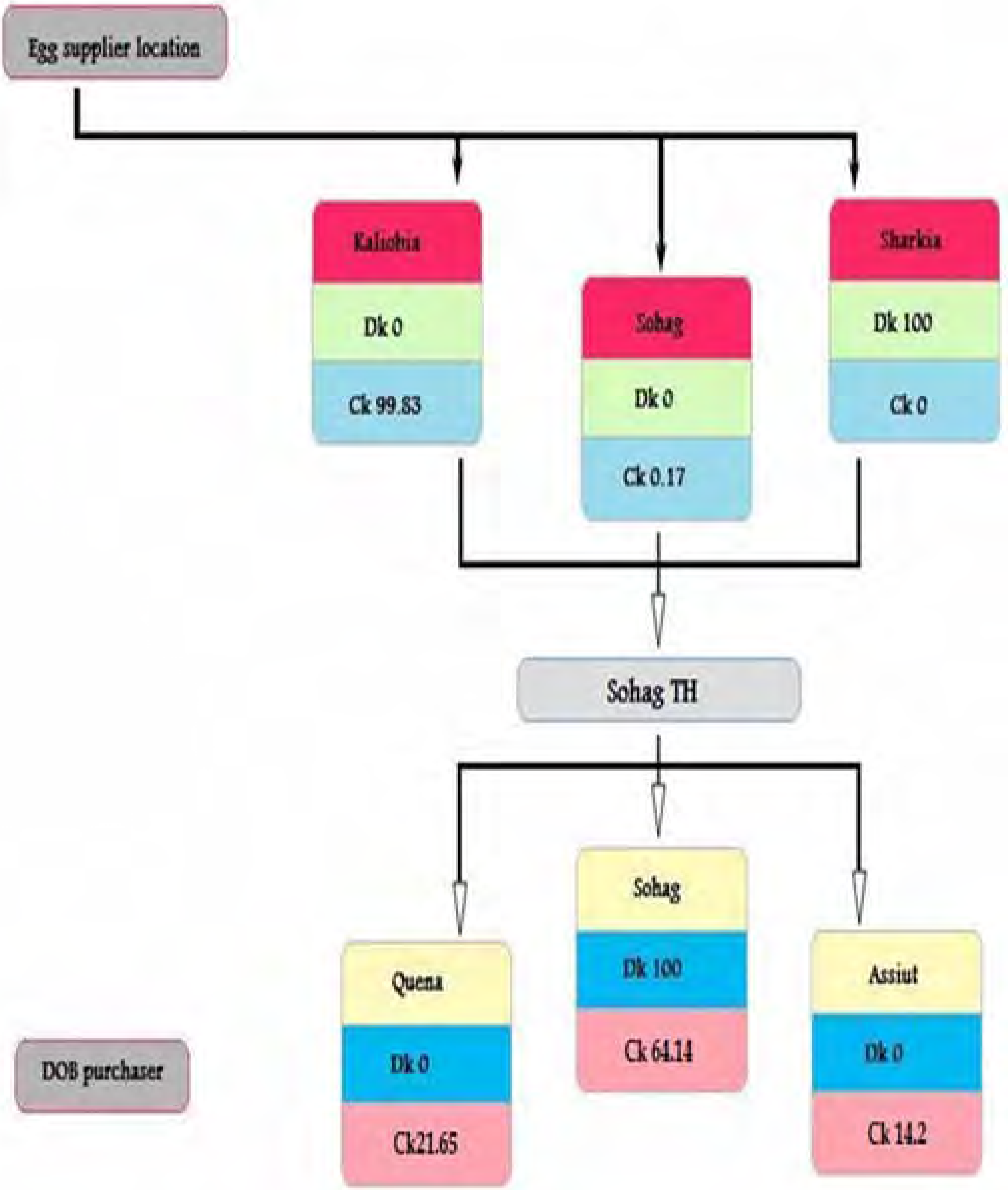
The 22 THs in Sohag (Figure 8) produced about 239 000 DOCs and 3 000 DODs a week in July and August 2008. They purchase nearly all their CK eggs from Qalyubia. Their clients for DOBs are located in Sohag, Quena and Asyut governorates (Figure 9).

Figure 8 Surveyed 22 THs in Sohag Governorate



CK			DK		
NO.	Symbol	Capacity	NO.	Symbol	Capacity
0	★ (orange)	40-60	1	▲ (orange)	20-30
12	★ (dark green)	61-80	0	▲ (dark green)	31-40
5	★ (blue)	81-100	0	▲ (blue)	41-60
3	★ (light green)	101-120	0	▲ (light green)	61-80
0	★ (magenta)	121-180	0	▲ (magenta)	81-100
1	★ (light blue)	181-240	0	▲ (light blue)	101-120

Figure 9 Locations of egg supplier and DOB purchaser from Sohag THs



Performance of THs

The performance of the THs as producing units was measured by estimating the egg hatchability percentage compared with that of modern hatcheries incubating the same breeds. The hatchability percentage depends on many factors, such as the age, health and nutrition status of the producing flock, the egg storage conditions, egg transportation management, hatchery operating techniques (egg turning process, temperature and humidity control) and hatchery sanitary measure. However, the hatchability percentages of THs were significantly lower than those of modern hatcheries incubating Baladi CK or DK eggs, in both incubation seasons (summer and winter) (Table 4). In addition, the hatchability of both types of egg was significantly higher in winter than summer in the THs (Table 4). The lower hatchability in THs could be attributed to poor or irregular temperature and humidity control, inefficient turning and limited sanitary measures. The difference in percentage hatchability between the two seasons could be attributed to Egypt's high summer temperatures (which may exceed 40 °C) affecting the productivity of the parent flock (nearly all egg producing flocks are kept in naturally ventilated buildings), the quality of eggs, egg storage, egg transportation, and temperature control in hatcheries.

Egg hatchability in Sohag THs was significantly lower, at $p > 0.05$, than that in Gharbia and Faiyoum THs (Table 4). This could be attributed to the long distances between egg producing farms in Qalyubia and Sohag governorates, where the journey may last more than ten hours in poorly ventilated trucks and on rough roads. Another factor could be that egg houses in Sohag THs are warmed by electric lamps fixed to the walls and without fans, which may result in uneven temperature distribution.

The economic losses resulting from the lower hatchability percentages in THs compared with modern hatcheries can be estimated from the total production by THs in the period under study (Table 4).

Table 4 Comparison of estimated hatchability (%) between traditional and modern hatcheries

Egg type	Season	Hatchery	No	Mean	Minimum	Maximum	Significance
Chicken	Winter	Modern	13	86.3	75	90	0.05
		Traditional	55	77.3	65	87	
	Summer	Modern	13	81.7	70	85	0.05
		Traditional	55	68.6	50	80	
	Gharbia	Traditional	7	75.1	65	82	0.05
	Faiyoum	Traditional	25	72.8	50	84	
	Sohag	Traditional	21	71.4	50	82	
Duck	Winter	Modern	3	86.3	85	89	0.05
		Traditional	45	74.6	60	92	
	Summer	Modern	3	81.7	80	85	0.05
		Traditional	45	64.8	50	85	

DOBs from THs show more dehydration and higher mortality rates during the first week of life than modern hatchery birds. The prices of DOBs produced by THs are therefore lower than those for birds from modern or modified hatcheries.

Table 5 Weekly economic losses of THs compared with modern hatcheries

Weekly loss of all surveyed TH incubating CK:
Mean difference (Table 4) between modern and TH (13.1%) X
Total DOC production by THs (510 x 103) = 66.810 X
Price of DOC at time of survey (1.2 LE)= 80 172 LE

All surveyed TH incubating DK :
Mean difference (table 4) between modern and TH (16.9%) X
Total DOD production by THs (192 x 10^3) = 32.499 X
Price of DOD at time of survey (2.2 LE) = 71 497 LE

Disease risk factors

Structure

The mud bricks used to build most THs allow disinfection by smoke or fumigation only.
None of the TH layouts consider the one-way flow of products, workers, air and trucks from clean to dirty zones. They have no facilities for washing and disinfecting vehicles.

Distance from nearest water canal

Distance from nearest water canal
About 9.5 percent of the surveyed THs are located less than 50 m (very close) from a water canal; 78.6 percent are more than 500 m (far) away from one, and the rest are between 50 and 500 m away (close) (Table 6).

Distance from nearest paved road

About 29.8 percent of the surveyed THs are very close to, 53.6 percent are close to and 16.7 percent are far from the nearest paved road (Table 6).

Distance from nearest poultry farm

The majority of THs (67.9 percent) are more than 500 m from the nearest poultry farm; 13.1 percent are very close and 19.8 percent are close (Table 6).

Distance from nearest poultry hatchery

Of the surveyed THs, 41.7 are very close to the nearest poultry hatchery, 33.3 percent are close and 25 percent are more than 500 m away (Table 6).
Nearly all the THs are surrounded by village houses, so they are very close to backyard and household birds.

Turning eggs

In all but the modified THs, eggs are turned by hand. Hatchery workers do not use protective gloves.

Table 6 Distance of 84 selected traditional hatcheries to other facilities (in percent of occurrence)

Facility	Distance*	Gharbia	Faiyoum	Sohag	Total
Water Canal	Very Close	6.3	20.0	0.0	9.5
	Close	18.8	3.3	13.6	11.9
	Distant	75.0	76.7	86.4	78.6
Paved Road	Very Close	31.3	33.3	22.7	29.8
	Close	50.0	60.0	50.0	53.6
	Distant	18.8	6.7	27.3	16.7
Poultry Farm	Very Close	28.1	3.3	4.5	13.1
	Close	40.6	3.3	9.1	19.0
	Distant	31.3	93.3	86.4	67.9
Poultry Hatchery	Very Close	59.4	33.3	27.3	41.7
	Close	40.6	23.3	36.4	33.3
	Distant	0.0	43.3	36.4	25.0

* very close< 50m, close=50-500m, distant> 500m

Egg spraying

All the THs spray water on the eggs to control their temperature.

Mixing species

Some 36.6 percent of the surveyed THs in Faiyoum and 18.75 percent of those in Gharbia incubate both DK and CK eggs at the same time (Table 7).

Table 7 Numbers of THs incubating single or mixed egg species

Type of eggs	Faiyoum		Gharbia		Sohag		Total	
	No.	%	No.	%	No.	%	No.	%
CK	14	46.6	3	9.4	21	95.5	38	45.2
DK	5	16.6	23	71.9	1	4.5	29	34.5
Both	11	36.6	6	18.7	0	0	17	20.3

Footwear disinfecting at entrance

No TH has a footbath at its entrance

Circulation of egg racks

Racks are routinely circulated between the TH and egg producing farms by 63.09 percent of the THs, and sometimes circulated by 16.7 percent (Table 8).

Table 8 Circulation of racks between THs and egg producing farms

Circulation of racks	Faiyoum		Gharbia		Sohag		Total	
	Number	%	Number	%	Number	%	Number	%
Routinely	22	73.3	22	68.7	9	40.9	53	63.1
Irregularly	7	23.3	4	12.5	3	13.6	14	16.7
Never	1	3.3	6	18.7	10	45.4	17	20.2

Litter removal

Wood shaving litter should be removed from the mid-passage regularly at every hatch, but only 21.4 percent of the surveyed THs do so (Table 9).

Table 9 Litter removal Frequency

Removal of litter	TH			Total	
	Fayoum	Gharbia	Sohag	No.	%
Regular removal	4	11	3	18	21.42
irregular	26	21	19	66	78.57
Total	30	32	22	84	

Use of rotational disinfection program

Only four of the 84 THs disinfect the hatcheries using different disinfectants in a rotation.

Presence of retail poultry equipments

About 10.7 percent of the surveyed THs retain equipment used to distribute birds.

Microbial monitoring

None of the surveyed THs monitor the implementation of sanitary measures.

Sanitation of transport vehicles

About 15 percent of the surveyed THs do not sanitize the vehicles used to transport DOBs; 10.7 percent do so after every delivery; and 71.4 percent at irregular intervals (Table 10).

Table 10 Sanitation of vehicles used to transport eggs and DOBs

THs	Sanitation of egg transport				Sanitation of DOB transport			
	No	Every delivery	Weekly	Irregular	No	Every delivery	Weekly	Irregular
Gharbia	1	6	1	24	0	7	1	24
Faiyoum	20	1	0	9	9	1	1	19
Sohag	6	0	0	16	4	1	0	17
Total	27	7	1	49	13	9	2	60
Percentage	32.1	8.3	1.2	58.3	15.5	10.7	2.4	71.4

Egg transporting vehicles are sanitized after every delivery by 8.3 percent of the surveyed THs, weekly by 1.2 percent and irregularly by 58.3 percent (Table 10).None of the surveyed THs uses disinfectant to sanitize the vehicles, but only detergents (Table 12).

It was noticed that two or three hatchery owners in Bardis, Balina district, Sohag governorate purchase CK eggs from the same egg producer, and use the same vehicles, to minimize transport costs. This sharing of an egg source allows them to judge both the quality of the eggs purchased and the skill of the hatchery workers.

Sanitation of DOB baskets

About 1.2 percent of the surveyed THs do not sanitize their DOB baskets (Table 11); 21.7 percent do so regularly after every delivery and the rest at irregular intervals. Only 2.4 percent of the THs use disinfectants in the sanitation process (Table 12).

Table 11 Sanitation of DOB baskets

THs	Sanitation of DOB baskets			Frequency of sanitation		
	Yes	No	Sometimes	Every delivery	Every 2 weeks	Every month
Gharbia	30	0	2	13	5	14
Faiyoum	28	1	1	3	5	21
Sohag	19	0	3	2	8	12
Total	77	1	6	18	18	47
Percentage	91.7	1.2	7.1	21.7	21.7	56.6

Table 12 Sanitation products used

THs	DOB basket sanitation with				Vehicle sanitation with			
	Water	Detergent	Both	Disinfectant	Water	Detergent	Both	Disinfectant
Gharbia	1	29	2	0	1	11	4	0
Faiyoum	9	12	7	1	0	8	2	0
Sohag	7	10	4	1	5	6	5	0
Total	17	51	13	2	6	25	11	0
Percentage	20.5	61.4	15.7	2.4	14.3	59.5	26.2	0

Disposal of TH waste

In Sohag governorate, the THs can depend on daily garbage collections for the disposal of hatchery waste products (egg debris, dead embryos and litter). In contrast, more than half of the THs surveyed in Faiyoum simply dump these materials on the roads outside the villages where their egg suppliers are located. The garbage collector in Berma village, Gharbia collects hatchery waste twice a week, but may simply dispose of the waste from more than 200 THs into water canals. Some duck growers in Gharbia use unhatched eggs that have been boiled and mixed with wheat bran or crushed maize as a feed for ducklings over seven days of age (Table 13).

Table 13 Disposal of hatchery waste

THs	Disposal of egg debris				Disposal of litter				
	Garbage collection	Water canal	Road	Sold	Garbage collection	Fertilizer	Sold	Incineration	Road
Gharbia	22	9	0	1	18	0	0	11	0
Faiyoum	5	9	16	0	11	2	0	9	8
Sohag	18	0	4	0	16	1	4	1	0
Total	45	18	20	1	45	3	4	21	8
Percentage	53.6	21.4	23.8	1.2	55.6	3.7	4.9	25.9	9.9

Use of veterinary services

Some 89.3 percent of the surveyed THs do not consult veterinary services about good practices (Table 14), and only 10.7 percent consult private veterinarians – none of them use official (government) services. The THs consulting veterinarians do so for diagnosis of the causes of lowered hatchability percentages and/or low-quality DOBs, to find out whether the egg producing farms or practices at the hatchery are to blame, and how to improve the performance of other incubated eggs from the same source.

Table 14 Use of veterinary services

THs	Use of Vet. Services			
		Yes		
	No	Private	Official	Total
Gharbia	24	8	0	32
Fayoum	29	1	0	30
Sohag	22	0	0	22
Total	75	9	0	84
Percentage	89.3	10.7	0	100

Advice to DOB purchaser

About 69 percent of the surveyed THs do not advise the DOB purchasers about the best conditions for rearing the birds they supply, but they do allow purchasers to select good birds (Table 15).

Feed back to egg supplier with low-quality egg.

Slightly more than 7 percent of the surveyed THs do not provide feedback to egg suppliers with low-quality eggs; instead, they change the source of eggs. The other THs inform suppliers about any quality problems, to encourage them to improve and, mainly, for compensation purposes (Table 15).

Table 15 Advice to DOB purchasers and feedback to egg producers

THs	Advice to DOB purchasers			Feedback to egg producers		
	Yes	No	Sometimes	Yes	No	Sometimes
Gharbia	8	23	1	32	0	0
Faiyoum	4	25	1	24	6	0
Sohag	2	10	10	21	0	1
Total	14	58	12	77	6	1
Percentage	16.7	69.0	14.3	91.7	7.1	1.2

Vaccination of DOBs

About 73 percent of surveyed THs vaccinate DOBs with inactivated avian influenza (AI) vaccines that are provided free of charge by Egypt's General Organization of Veterinary Services (GOVS) (Table 16). They vaccinate DOBs with 0.2 ml of vaccine by subcutaneous inoculation. Two types of vaccines are used: the Chinese vaccine H5N1 (reassortant vaccine, prepared from A/goose/Guandong/1/1996 HPAI H5N1 by reverse genetics); and H5N2 vaccine (prepared from A/DK/Potsdam1402-6/1986, H5N2 low pathogenic virus strain).

Table 16 Vaccination and treatment of DOBs

THs	Frequency of vaccination			Type of Treatment			
	No	Sometimes	Yes	AI*	Ab#	Marek	Yolk
Gharbia	4	17	11	27	8	1	1
Faiyoum	4	26	0	26	1	0	0
Sohag	14	8	0	8	0	0	0
Total	22	51	11	61	9	1	1
Percentage	26.2	60.7	13.1	72.6	10.7	1.2	1.2

* Inactivated AI vaccine. # Antibiotic

About 10.7 percent of the surveyed THs treat DOBs with subcutaneous inoculation of antibiotics, mainly gentamycin sulfate, to minimize and control mortalities in the first week of life.

A few hatchery owners provide DOD growers with duck eggs from duck breeder flock that has recently been vaccinated with duck hepatitis vaccine, so that the growers can use the egg yolks in addition to the antibiotics for emergency control in case of duck virus hepatitis infection. THs vaccinate DOCs with Marek's disease vaccine only if the birds are to be raised as breeders and the purchaser has requested it.

Rearing of the DOBs by the THs

Nearly 68 percent of hatchery owners that produce DOBs do not raise the young birds; 11.9 percent raise birds on farms adjacent to their THs, and 19.1 percent on the roofs of their THs. One TH owner raises chicks on a separate farm (Table17).

Table 17 Rearing of birds by the THs

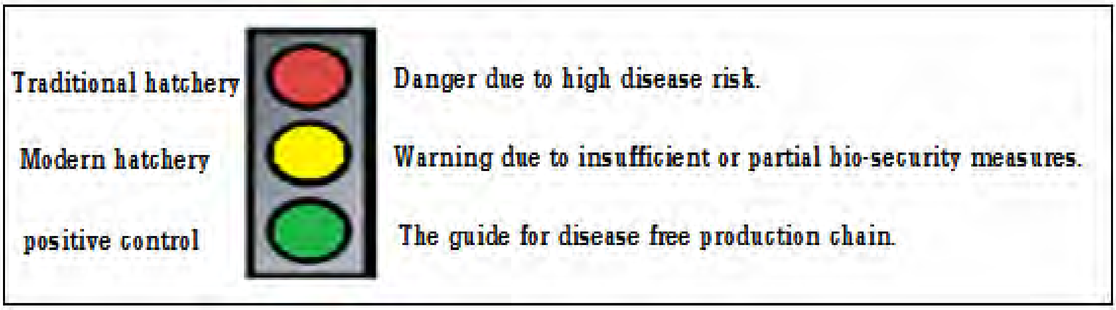
THs	No	Yes		
		Close to TH	On roof of TH	Farm
Gharbia	18	5	9	0
Faiyoum	19	4	7	0
Sohag	20	1	0	1
Total	57	10	16	1
Percentage	67.9	11.9	19.1	1.2

Assessment of risk factors

Because different types of DOBs are produced, the assessment of disease risk factors at THs compared with those at positive controls was done by the chi-square test based on field observations only. The expectation by chi-square was similar to the observation (data not shown). The positive control hatcheries were considered to be at low disease risk as they carry out both bio-exclusion (to prevent the introduction and spread of new infection agents into the hatchery) and biocontainment measures (to prevent the spread of current and existing pathogens within the hatchery, or their release from the hatchery; Thieme, 2007). On the traffic light system illustrated below, the control cases can be placed in the green light or safe zone.

None of the surveyed THs practised either bio-exclusion or biocontainment measures, so they can be categorized in the high-risk or red light zone.

With the partial or insufficient application of bio-exclusion and biocontainment practices by the modern and modified hatcheries (incubating Baladi eggs), they are ranked in the red or warning yellow light zones.



Genetic relationships among different H5N1 isolates

The low sanitary measures and unhygienic practices found throughout the production network motivated an investigation of the relations among different locations involved in trading Baladi breeds. This investigation was based on the different HPAI H5N1 viruses isolated in the survey locations, referring to the time of sample collection and the host of the isolates responsible for most of the human cases caused by contact with backyard birds (Saad *et al.,* 2008).

The phylogenetic tree of the haemagglutinin gene of selected isolates (Figure 10) confirmed that there is a close genetic relationships evolving from one introduction. It showed that all the clusters of the tree contain a mixture of isolates from different geographical locations (marked with coloured symbols on the left of the isolate name). In addition to the three clusters of the Nile Delta (green diagonals), Lower Egypt (yellow squares) and Upper Egypt (dark green triangles) regions (Saad *et al.,* 2008), a new cluster containing variant strains has evolved from the Nile Delta region (red circles). In late 2007, this new cluster also contained isolates from Quena governorate among the Nile Delta governorates, as well as two World Health Organization (WHO) recommended pre-pandemic vaccine strains.

To trace the time and location of H5N1 virus emergence and spread within the selected areas, the geographical location of each selected virus was plotted on a map of Egypt and linked to full identical viruses (Figure 11). The evolved variant virus labelled with a red circle was first detected on 3 November 2007 in Sharqia governorate, then on 18, 19 and 30 December 2007 in Qalyubia, Quena and Beheira governorates respectively. Comparing the haemagglutinin gene amino acid sequences of these four isolates showed that they are 100 percent identical (Annex 3). In spite of the long distance between Qalyubia and Quena governorates, of more than 700 km, the same virus was isolated at nearly the same time, confirming the previous finding that the viruses move freely and rapidly in the production chain.

In addition, the same 100 percent identities of haemagglutinin gene sequence were found among human isolates in Faiyoum and poultry isolates in Gharbia, Beheira, Alexandria and Giza governorates (green diagonals in Figure 10, and Annex 3). The same observation occurred in the cluster labelled with green triangles: human isolates in Sohag (which purchases 99.8 percent of its CK eggs from Qalyubia governorate), Quena (which raises 21 percent of the DOCs produced by Sohag THs) and Qalyubia (which is the main CK egg-producing governorate, Table 2) are identical. (The strain names, accession numbers, hosts, collection locations and times of collection of each isolate symbol are listed in Table 1.)

Figure 10 Phylogenetic analysis of haemagglutinin gene of selected Egyptian H5N1 isolates

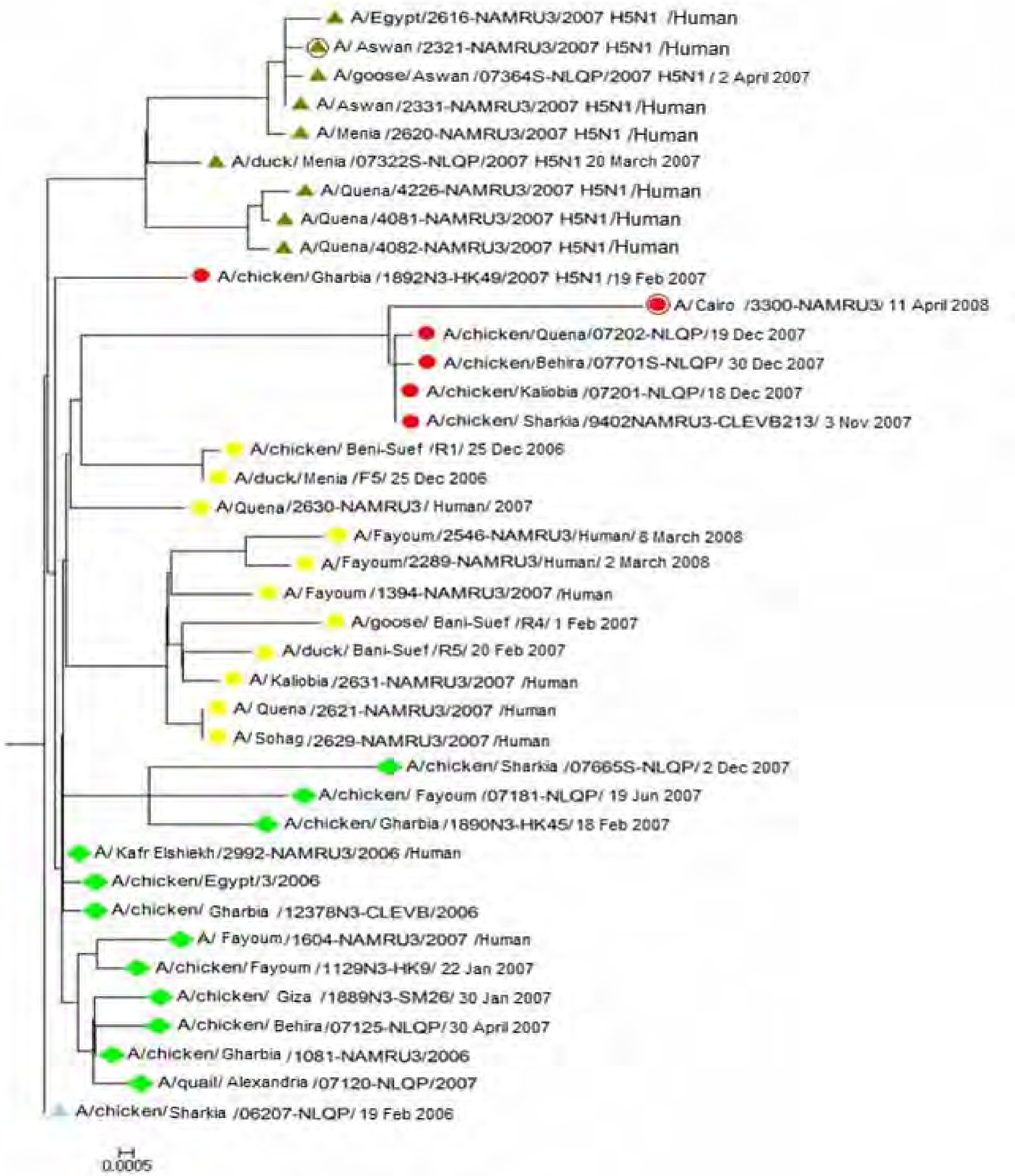


Figure 11 Geographical distribution of selected H5N1 viruses isolated in Egypt from 2006 to 2008. The two pre-pandemic strains are surrounded by red circles. The ABV24031 virus is not shown as its geographical location is not known

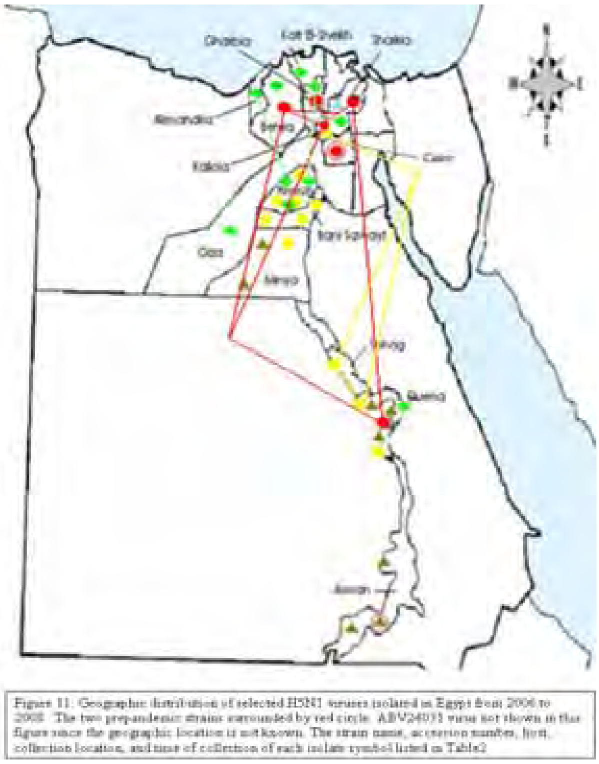


Figure 12 Occurrence of H5N1 outbreaks in a six-month period (higher frequency in January 2008 in different geographical locations in Egypt)

Source: Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES).

Limitations to the survey

Time of survey

July and August are considered the low season for DOB production by THs owing to hot weather, decreased egg hatchability percentages and lower DOB quality. It would have been better to carry out the survey in winter, the maximum production season.

Governorates surveyed

During the field visit to Sohag governorate, hatchery owners and distributors reported that Asyut governorate is the main supplier of ducklings for Upper Egypt governorates. There are more than 100 THs in the Dairot district of Asyut alone.

Price of poultry feed

In July 2008, there was a sharp increase in the price of formulated poultry feed, from LE 2 200 to LE 3 200 per tonne. This resulted in a situation similar to that of the February 2006 HPAI outbreak, where there was no demand for DOBs. In addition, villagers were preparing for the sacred month of Ramadan, and many owners had closed their hatcheries.

Hatchery owners

Owners are not always willing to share information about their businesses, and the advantages of participating in this survey were not often evident to them. During the 2006 HPAI outbreak, most incubated eggs and hatched birds were condemned owing to market paralysis. Hatchery owners were not compensated in the way that poultry growers and nurseries were, so they are now less willing to cooperate with authorities. The data collected were the result of knowledge exchange between the hatchery owners and the research consultant.

Hatchery records

THs' records of egg suppliers and DOB purchasers tend to be poor. Survey results regarding the egg and DOB network should therefore be interpreted with great caution.

When the TH survey began, the ECTAD team leader in Egypt (Dr Rob de Rooij) was on annual leave. The national coordinator (Dr Zahra Ahmed) also had a three-week gap between contracts (although she followed activities over the phone) which resulted in a lack of guidance and planning at the start of the study.

Information feedback

In their 2007 report, Pagani and Kilany mention that egg houses may be divided into two or three levels. None of the THs surveyed for this study had egg houses or ovens on three levels. The same authors report that there are water containers inside the ovens to keep the humidity level high, but the researchers in this study found that the water is kept in the mid-passage, not the ovens, and is just warm. Each TH has only one water container, for wetting eggs in cases of elevated egg temperature. Hatchery workers do not have equipment for measuring relative humidity. Pagani and Kilany claim that the petrol lamp is the only heat source for warming egg ovens, but in nearly all the THs in Sohag governorate surveyed for this study electric lamps are used instead of petrol ones.

Pagani and Kilany mention that veterinary vaccines are taxed at a high rate of about 25 percent, but vaccine importers in Egypt confirmed that vaccines are exempt from tax, except for the less than 3 percent tax charged on recently registered vaccines. The same authors reported a shortage of poultry vaccines on the market, and waiting periods of several months before orders are received. In fact, there is aggressive competition among the more than 15 companies and offices of international vaccine producers to supply vaccines to distributors and/or poultry farms directly. Therefore, most of the time, several vaccine strains for a disease are available. Occasionally, however, poultry producers face a shortage of a specific strain produced by a specific manufacturer because the market demand for that strain is higher than expected by the vaccine importer, or because of a disease outbreak either in Egypt or worldwide.

During field visit to Sohag governorate, the researchers visited the Ekthar Eldawagen Project, which raises, maintains and produces CKs of the pure Faiyoumi breed. Eng Naser, the Chairperson of this project, reported that the farm had not been exposed to infection with HPAI H5N1 virus since the 2006 outbreak. This is additional information to the report prepared by Hosny (2006).

Photo 10 Pure Fayoumi breed raised by Ekthar Eldawagen Project.

Discussion and recommendations

Aristotle, writing in 400 BC, reported that the ancient Egyptians artificially incubated poultry eggs on a large scale in dung heaps (Nesheim Malden, Austic and Card, 1979; Parkhurst and Mountney, 1987; Grimes and Pardue, 1996; Berry, no date). The skill of incubation has been passed down the generations up to the present day (Asker, 1927; El-Ibiary, 1946; Taylor, 1949; Landauer, 1951).

All the THs surveyed in this study incubate improved CK hybrid breeds, most of which are raised by growers for two or six weeks before being sold to village women. Village households raise the CKs as a source of eggs and meat or small income. All the DK eggs incubated by THs are hybrids of crossed Peking and Khaki Campbell breeds. DKs are raised for two weeks in nurseries, before being distributed to villagers. Of the 32 THs surveyed in Gharbia governorate, 71.9 percent incubate DK eggs, 9.4 percent CK eggs and 18.7 percent both. Of the 30 Faiyoum THs, 46.6 percent incubate CK eggs, 16.6 percent DK eggs and 36.6 percent both types. In Sohag, 95.5 percent of the 22 THs surveyed incubate CK eggs and 4.5 percent DK eggs.

The network of movements of Baladi eggs to and DOBs from THs has important implications for disease invasion and spread, and studying it can provide scientific support for preventive and control measures. Qalyubia governorate provides 69.8 percent of the CK eggs used by the 84 surveyed THs, followed by 24.4 percent from Faiyoum governorate, and 3 percent from Gharbia governorate. The main source of DK eggs is Gharbia, supplying 38.6 percent, followed by Beheira governorate with 26.7 percent, and Qalyubia governorate with 12 percent.

The highest percentages of DOC growers are located in Faiyoum, with 39.8 percent, followed by 30 percent in Sohag, 10.1 percent in Quena and 6.7 percent in Asyut governorates. Gharbia governorate accounts for 32.3 percent of total DOD purchases, followed by 13.4 percent in Beheira and 4.5 percent in Qalyubia governorates.

DOBs from the THs show more dehydration and higher mortality rates in the first week of life. This reduced vitality could be attributed to inhomogeneous temperatures and relative humidity control, in addition to higher microbial load stresses resulting from a lack of sanitary practices. In the period of the study (summer 2008), the estimated losses of the 84 surveyed THs resulting from significantly decreased hatchability compared with modern hatcheries were about 66 810 DOCs and 32 499 DODs a week. In addition, the prices of DOBs produced by modern hatcheries may be 0.10 to 0.25 LE/bird higher than those for THs' DOBs.

It is recommended that a similar study be carried out in the winter season, when HPAI incidence is higher, to estimate the maximum DOB production, and the contribution of each geographical location to the trade in Baladi birds. It is also important to survey Asyut governorate, which contains more than 100 THs and is considered the main source of ducklings for Upper Egypt governorates.

Regarding disease risk factors, the mud bricks used in building the THs permit disinfection with fumigation only. The location of THs among village houses puts them at high risk from neighbouring backyard and household birds. Gentry, Mitrovic and Bubach (1962) found that hatcheries with poor floor design and faulty traffic patterns were highly contaminated compared with those with one-way flows. It is therefore important to relocate hatcheries outside villages, away from sources of poultry pathogens, and to build them out of water-proof materials with a layout that prevents the crossing of eggs and DOBs and allows a one-way flow of products, workers and vehicles.

Turning eggs by hand without gloves is considered a risk factor, as damage of thin-shelled eggs leads to the spread of embryo material to the surrounding eggs, favouring the growth of micro-organisms. Egg turning in this manner also facilitates the transmission of food-borne disease organisms from eggs to workers, and vice versa.

Egg wetting with sanitized or unsanitized water to control temperature can result in contamination. Any moisture on warm eggshells evaporates, thus cooling the eggs, but lowering the internal pressure, which drives contaminants through the pores into the eggs (Hubbard, 2002).

In the Gharbia and Faiyoum THs that incubate CK and DK eggs at the same time, there is the risk that one species is resistant to or silently infected by a disease and could therefore act as a reservoir or carrier of the infection to the other susceptible species.

The circulation of egg racks among THs and poultry farms opens the way for disease transmission between the two nodes.

The lack of strict disinfection of DOB baskets and vehicles at TH entry gates facilitates disease circulation along the production chain.

The disposal of egg debris and dead eggs without treatment, in water canals or along roads leading to poultry farms may lead to water pollution and/or scavenging by wild birds resulting in disease outbreaks and endemics. Daily collection of waste products and their proper disposal by local authorities is an important matter.

The irregular removal of litter from the mid-passages of hatcheries, along with the lack of microbial monitoring, is likely to result in persistent and continuous infection of THs. Gentry, Mitrovic and Bubach (1962) described how, as CKs hatch, the exposed embryo fluids collect bacteria from contaminated shells and ventilation air. This combination of nutritious fluids and warm temperature provides an excellent environment for bacteria to multiply very rapidly.

The study concluded that the Baladi breed production network is liable to disseminate not only HPAI but also other disease agents (e.g., food-borne diseases) across Egypt, and could provide the infectious seeds for virtually all regional epidemic foci.

Most of the THs vaccinate DOCs with inactivated AI vaccine supplied free of charge by GOVS. The vaccination of DOBs with suboptimal doses masks or obscures the symptoms of HPAI infection. Taha *et al.* (2008) isolated two escape mutant H5N1 viruses responsible for the HPAI wave in late 2007 and early 2008 in the Nile Delta region, and attributed the mutations to weak vaccine pressure. Revaccination with a full dose at two weeks of age is therefore essential.

Very few THs vaccinate DOCs with Marek`s disease vaccine, other than DOCs to be raised as breeders by egg producing farms. Such vaccination is important for minimizing the immunosuppressive effect of the disease and to provide immune-competent CKs to the rural sector.

There is a lack of awareness about the basic principles of disease prevention among hatchery owners and workers. THs are usually successful when markets are favourable, but cannot compete with modern or modified hatcheries when profit margins are very small, such as during the summer season.

There is clear seasonality, with high operating capacity in the winter season (January to April) along with significantly increased hatchability, demonstrated by periods of intense rearing and growing birds. Given the poor sanitary measures found, an epidemic that starts during this period has the potential to reach many poultry farms and to damage the rural network by seeding endemic foci. This was confirmed by the high incidence of H5N1 AI during winter 2008 (Figure 12) and the full identity of haemagglutinin gene sequences of H5N1 viruses isolated in Upper Egypt governorates (which are completely dependent on Nile Delta governorates as sources of hatching eggs) with Nile Delta region strains, indicating the direct transmission of such viruses from Nile Delta governorates to southern Egypt. Although Egyptian strains are categorized into three main geographical clusters – Nile Delta, Lower

Egypt and Upper Egypt (Saad *et al.,* 2008) – the phylogenetic tree and blast 2 results generated by this study demonstrate that each cluster contains mixtures of identical isolates from other geographical regions. Particularly noteworthy among these is the newly evolved cluster (labelled with red circles), which contains a fully identical isolate from Quena governorate in Upper Egypt among variant strains from Qalyubia, Beheira and Sharqia governorates in the Nile Delta region, confirming that viruses can move freely and rapidly in all directions to reach all the nodes of the poultry production network. Stevens *et al.* (2008) highlight the increased propensity of HPAI H5N1 clade 2.2 viruses to acquire human receptor specificity. Taha *et al.* (2008) and WHO/OIE/FAO (2008) mention that the Egyptian strains belong to clade 2.2. Enhanced biosecurity and surveillance during the winter period of increased HPAI virus activity is therefore likely to benefit disease control.

Although THs succeed in incubating hatching eggs, neither their structures nor their practices provide either bio-exclusion or biocontainment. Planning and support for the relocation and redesign of THs, after proper consultation, should be considered and funded by non-governmental organizations (NGOs) and government authorities. Educational conferences on health goals to raise hatchery staff's knowledge of biosecurity and improved practices would help increase awareness.

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Annexes

Annex 1 Survey questionnaire for traditional hatcheries.

Governorate: _________________________________Village:______________________

Name of the hatcheries owner: __________________ Tel: ________________________

Name of the respondent: ____

Job of the respondent: ____

Interviewer: ________________________________ Date: __________________

A- Location :

1- GPS Coordinates______________________________

2-

B- Type of hatchery :

□1-Manual (traditional) □2- Semi □ 3- Automatic (modern)

C- capacity and type and season of operation :

C-1- Does your hatchery work permanently. □1- Yes □2- No

C-2- What is maximum capacity of this hatchery? ---------------------

C-3- What is the operational capacity of this hatchery? ---------------

C-4- Does the working capacity of your hatchery change with the season?
□1- Yes □2- No

C-5- Do you keep record of the hatchability?
□1- Yes □2- No

C-6- What is the season of the year with the highest hatchability?
□1- summer □2- winter

C-7- What is the percentage of hatchability?
□1- summer …… □2- winter……..

C-8- Do you use veterinary services for your hatchery?
□1- Yes □2- No

C-9- If the answer is yes, what type of veterinary services do you use?
□1- Official Vet services □2- Private Vet services

C-10- Do you vaccinate or treat your 1-day old chick and/or duckling?
□1yes □2- No □ 3-Sometimes

C-11-If yes, for which diseases do you vaccinate your birds?
□1- Marek vac □2- AI vacc. □ 3- DVH vac □ 4- Antibiotic □5- Other specify

C-12- Do you inform the ckick/duckling purchaser for best condition for starting birds?
□1yes □2- No □ 3-Sometimes *C-*

13- Do you feed back egg supplier with abnormal egg hatchability %?
□1yes □2- No □ 3-Sometimes

D- source/type of eggs used for incubation and main suppliers of Baladi type eggs for hatching :

D-1- What is the type of hatched Egg?
□1- Baladi type Chicken □2- Baladi type Ducks □3- Chicken
□4- Ducks □5- Mixed type □6- Others (specify)

D-2- What are the source of the hatched eggs?
□1- own production □2- purchased from the farm directly □3- Market
□4- purchased from middleman □5- Both □ 6-Others (specify)

D- 3 –Source of your eggs:

D- 3 -1-Ssource of your chicken eggs?
□1- the same governorate □2- other governorate, specify

D- 3 -1-1 – if other, where and percentage?
□1- □2- □ 3- □ 4-

D- 3 -2 –Source of duck eggs?
□1- the same governorate □2- other governorate, specify

D- 3 -2-1 – if other, where and percentage?
□1- □2- □ 3- □ 4-

E- sanitary measures :

E.A- Constant measures:

E.A-1- Distance from water canal?
□1-Very close (m) □2-Close (m) □3-Far (m)

E.A-2- Distance from paved road?
□1-Very close (m) □2-Close (m) □3-Far (m)

E.A-3- Distance from nearest poultry farm
□1-Very close (m) □2-Close (m) □3-Far (m)

E.A-4- Distance from nearest poultry hatchery
□1-Very close (m) □2-Close (m) □3-Far (m)

E.B- Variable measures:-

E.B.1- Do you use footbath in you hatchery?
□1- Yes □2- No

E.B.2 - Is there ventilation in the hatchery?
□1- Yes □2- No

E.B.3- If the answer is yes, what is the type of ventilation?
□1- Natural □2- Artificial

E.B.4- Are pets allowed to roam on the hatchery?
□1- Yes □2- No

E.B.5- Are insects controlled?
□1- Yes □2- No

E.B.6-If the answer is yes, how it applied ?
□1-insecticides powder □2-spray

E.B.7- Are rodent controlled?
□1- Yes □2- No □3-sometimes

E.B.8 - If the answer is yes how rodent control is practiced?
□1- Rodent proof door □2- Rodent trap □3-chemical poisons □4-Both

E.B.9- Do you use disinfectants?
□1- Yes □2- No □3-sometimes

E.B.10-If the answer is yes, describe the mode of disinfection?

□ 1- By fixed type □ 2-By rotating between disinfectants
□ 3-- Other specify

E.B.11- Dose the hatchery men wash their hands before egg handling/turning ?
□1- Yes □2- No □3-Sometimes

E.B.12- Dose the hatchery men are working in more than one hatchery at the same time?
□1- Yes □2- No □3-Sometimes

E.B.13 - Do you use clean and disinfected water to spray/condition the hatching eggs?
□1- Yes □2- No □3-Sometimes

E.B.14 - Do you sanitize the eggs before hatching?
□1- Yes □2- No □3-Sometimes

E.B.15 – If the answer is yes, what is the type of the used sanitizer?
□1- Disinfectants □2- Clean Water
□3- Rotating between water and disinfectants □4- Other (specify)

E.B.16- How do you dispose Egg /debris/dead chicks?
□ 1- Garbage collector □ 2-incineration
□ 3-Sell □ 4- Other specify

E.B.17- dose you disinfect one- day old bird- boxes?
□1- Yes □2- No □3-Sometimes

E.B.18- If the answer is yes, using what:
□ 1- Water □ 2-detergent □ 3-Disinfectant □4-Both

E.B.19- Frequency of bird boxes sanitation.
□1- Every hatch □2-Every 2 weeks □3-Monthly

E.B.20- Circulation of egg racks?
□1- Yes □2- No □ 3-sometimes

E.B.21- do you disinfect egg traffics?
□1- Yes □2- No

E.B.22- If the answer is yes, when?
□1-Every delivery □2- weekly □3-Irregularly

E.B.23- What type of traffic disinfectants?
□ 1- Clean water □ 2-detergent. □3-Disinfectant □ 4-Both

E.B.24- do you disinfect one-day old traffics?
□1- Yes □2- No

E.B.25- If the answer is yes, when?
□1-Every delivery □2- weekly □3-Irregularly

E.B.26- Microbial monitoring of the hatchery?
□1- Yes □2- No

E.B.27- Removal of litter ?
□1- Every hatch. □2-Weekly □3-Every 2 weeks □4-Monthly

E.B.28-Disposale of litter?
□1- Sell □2-Garbage collector □ 3-Fertilizer

E.B.29-Presence of retail equipments?
□1- Yes □2- No

F.A.marketing :

F-1-Do you sell the produced chicks and/or duckling?
□1- Yes □2- No

F-2-If yes, where?

F.2.1.Chicks
□1- To neighbours in the same area
□2- To poultry grower in the same Governorate
□3- To poultry grower in the neighbouring Governorate, specifies:
□4- To traders that come to the village, Specify
□5- other (specify)

F.2.2.Ducklings
□1- To neighbours in the same area
□2- To poultry grower in the same Governorate
□3- To poultry grower in the neighbouring Governorate, specifies:
□4- To traders that come to the village, Specify
□5- other (specify)

F-3-Do you nurse your own produced chicks and/or duckling?
□1-yes □2- no

F- 4- If yes where?
□1- In back yard /at roof
□2- Close to the hatchery
□3- In nurseries owned by the hatchery
□4- other (specify)

Annex 2: Blast 2 Sequences results

NCBI Blast 2 Sequences results

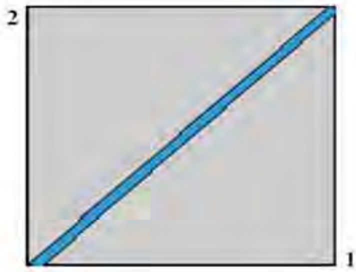
PubMed | Entrez | BLAST | OMIM | Taxonomy | Structure

BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]

Matrix BLOSUM62 gap open: 11 gap extension: 1
x_dropoff: 0 expect: 10.000(wordsize: 3 Filter View option Standard
Masking character option X for protein, n for nucleotide Masking color option Black
Show CDS translation Align

Sequence 1: ACA29672 *Quena isolate* *(A/Ck/Egypt/07202-NLQP/2007 (H5N1)*
Length = 568 (1 .. 568)

Sequence 2: ACA29680 *Behira isolate* *(A/Ck/Egypt/07701-NLQP/2007 (H5N1)*
Length = 553 (1 .. 553)



NOTE:Bitscore and expect value are calculated based on the size of the nr database.

```
 Score = 1146 bits (2964),  Expect = 0.0
 Identities = 553/553 (100%), Positives = 553/553 (100%), Gaps = 0/553 (0%)

Query  16    SDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAG  75
             SDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAG
Sbjct  1     SDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAG  60

Query  76    WLLGNPMCDEFLNVSEWSYIVEKINPANDLCYPGNFNNYEELKHLLSRINRFEKIQIIPK  135
             WLLGNPMCDEFLNVSEWSYIVEKINPANDLCYPGNFNNYEELKHLLSRINRFEKIQIIPK
Sbjct  61    WLLGNPMCDEFLNVSEWSYIVEKINPANDLCYPGNFNNYEELKHLLSRINRFEKIQIIPK  120

Query  136   SSWPDHEASSGVSSACPYQGGPSFYRNVVWLIKKDNAYPTIKKSYHNTNQEDLLVLWGIH  195
             SSWPDHEASSGVSSACPYQGGPSFYRNVVWLIKKDNAYPTIKKSYHNTNQEDLLVLWGIH
Sbjct  121   SSWPDHEASSGVSSACPYQGGPSFYRNVVWLIKKDNAYPTIKKSYHNTNQEDLLVLWGIH  180

Query  196   HPNDEAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRVEFFWTILKSNDAI  255
             HPNDEAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRVEFFWTILKSNDAI
Sbjct  181   HPNDEAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRVEFFWTILKSNDAI  240

Query  256   NFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTI  315
             NFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTI
Sbjct  241   NFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTI  300

Query  316   GECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNE  375
             GECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNE
Sbjct  301   GECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNE  360

Query  376   QGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFL  435
             QGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFL
```

```
Sbjct  361  QGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFL  420

Query  436  DVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECM  495
            DVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECM
Sbjct  421  DVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECM  480

Query  496  ESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLW  555
            ESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLW
Sbjct  481  ESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLW  540

Query  556  MCSNGSLQCRICI  568
            MCSNGSLQCRICI
Sbjct  541  MCSNGSLQCRICI  553


CPU time:     0.04 user secs.     0.03 sys. secs        0.07 total secs.
```

Blast 2 Sequences results

NCBI

PubMed   Entrez   BLAST   OMIM   Taxonomy   Structure

BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]

Matrix BLOSUM62 gap open: 11 gap extension: 1

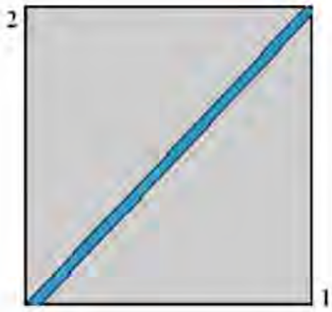
x_dropoff: 0 expect: 10.000(wordsize: 3 Filter View option Standard

Masking character option X for protein, n for nucleotide Masking color option Black

Show CDS translation Align

Sequence 1: ACA29672 *Quena isolate*
Length = 568 (1 .. 568)

Sequence 2: ACA29671 *Kalioubia isolate*
Length = 552 (1 .. 552)



NOTE: Bitscore and expect value are calculated based on the size of the nr database.

```
 Score = 1144 bits (2960),  Expect = 0.0
 Identities = 552/552 (100%), Positives = 552/552 (100%), Gaps = 0/552 (0%)

Query  17   DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAGW  76
            DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAGW
Sbjct  1    DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAGW  60

Query  77   LLGNPMCDEFLNVSEWSYIVEKINPANDLCYPGNFNNYEELKHLLSRINRFEKIQIIPKS  136
            LLGNPMCDEFLNVSEWSYIVEKINPANDLCYPGNFNNYEELKHLLSRINRFEKIQIIPKS
Sbjct  61   LLGNPMCDEFLNVSEWSYIVEKINPANDLCYPGNFNNYEELKHLLSRINRFEKIQIIPKS  120

Query  137  SWPDHEASSGVSSACPYQGGPSFYRNVVWLIKKDNAYPTIKKSYHNTNQEDLLVLWGIHH  196
            SWPDHEASSGVSSACPYQGGPSFYRNVVWLIKKDNAYPTIKKSYHNTNQEDLLVLWGIHH
Sbjct  121  SWPDHEASSGVSSACPYQGGPSFYRNVVWLIKKDNAYPTIKKSYHNTNQEDLLVLWGIHH  180

Query  197  PNDEAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRVEFFWTILKSNDAIN  256
            PNDEAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRVEFFWTILKSNDAIN
Sbjct  181  PNDEAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRVEFFWTILKSNDAIN  240

Query  257  FESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIG  316
            FESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIG
Sbjct  241  FESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIG  300

Query  317  ECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQ  376
            ECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQ
Sbjct  301  ECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQ  360

Query  377  GSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLD  436
            GSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLD
```

```
Sbjct  361  GSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLD  420

Query  437  VWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECME  496
            VWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECME
Sbjct  421  VWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECME  480

Query  497  SVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWM  556
            SVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWM
Sbjct  481  SVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWM  540

Query  557  CSNGSLQCRICI  568
            CSNGSLQCRICI
Sbjct  541  CSNGSLQCRICI  552


CPU time:     0.05 user secs.       0.03 sys. secs         0.08 total secs.
```

NCBI Blast 2 Sequences results

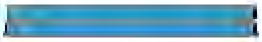
PubMed Entrez BLAST OMIM Taxonomy Structure

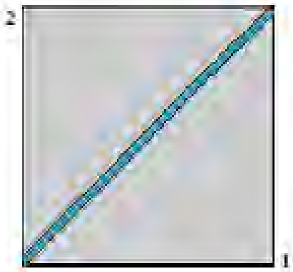
BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]

Matrix BLOSUM62 gap open: 11 gap extension: 1
x_dropoff: 0 expect: 10.000(wordsize: 3 Filter View option Standard
Masking character option X for protein, n for nucleotide Masking color option Black
Show CDS translation Align

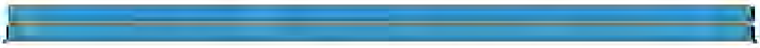
Sequence 1: ABP98854 **Quena/Human/2007**
Length = 549 (1 .. 549)

Sequence 2: ABU53970 **Kaiobia/Human/2007**
Length = 557 (1 .. 557)





NOTE: Bitscore and expect value are calculated based on the size of the nr database.



Score = 1136 bits (2939), Expect = 0.0
Identities = 549/549 (100 %), Positives = 549/549 (100%), Gaps = 0/549 (0%)

```
Query  1    DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAGW  60
            DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAGW
Sbjct  6    DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDLDGVKPLILRDCSVAGW  65

Query  61   LLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHLLSRINHFEKIQIIPKS  120
            LLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHLLSRINHFEKIQIIPKS
Sbjct  66   LLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHLLSRINHFEKIQIIPKS  125

Query  121  SWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSYNNTNQEDLLVLWGIHH  180
            SWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSYNNTNQEDLLVLWGIHH
Sbjct  126  SWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSYNNTNQEDLLVLWGIHH  185

Query  181  PNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRMEFFWTILKSNDAIN  240
            PNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRMEFFWTILKSNDAIN
Sbjct  186  PNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRMEFFWTILKSNDAIN  245

Query  241  FESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIG  300
            FESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIG
Sbjct  246  FESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIG  305

Query  301  ECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQ  360
            ECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQ
Sbjct  306  ECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQ  365

Query  361  GSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLD  420
            GSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLD
```

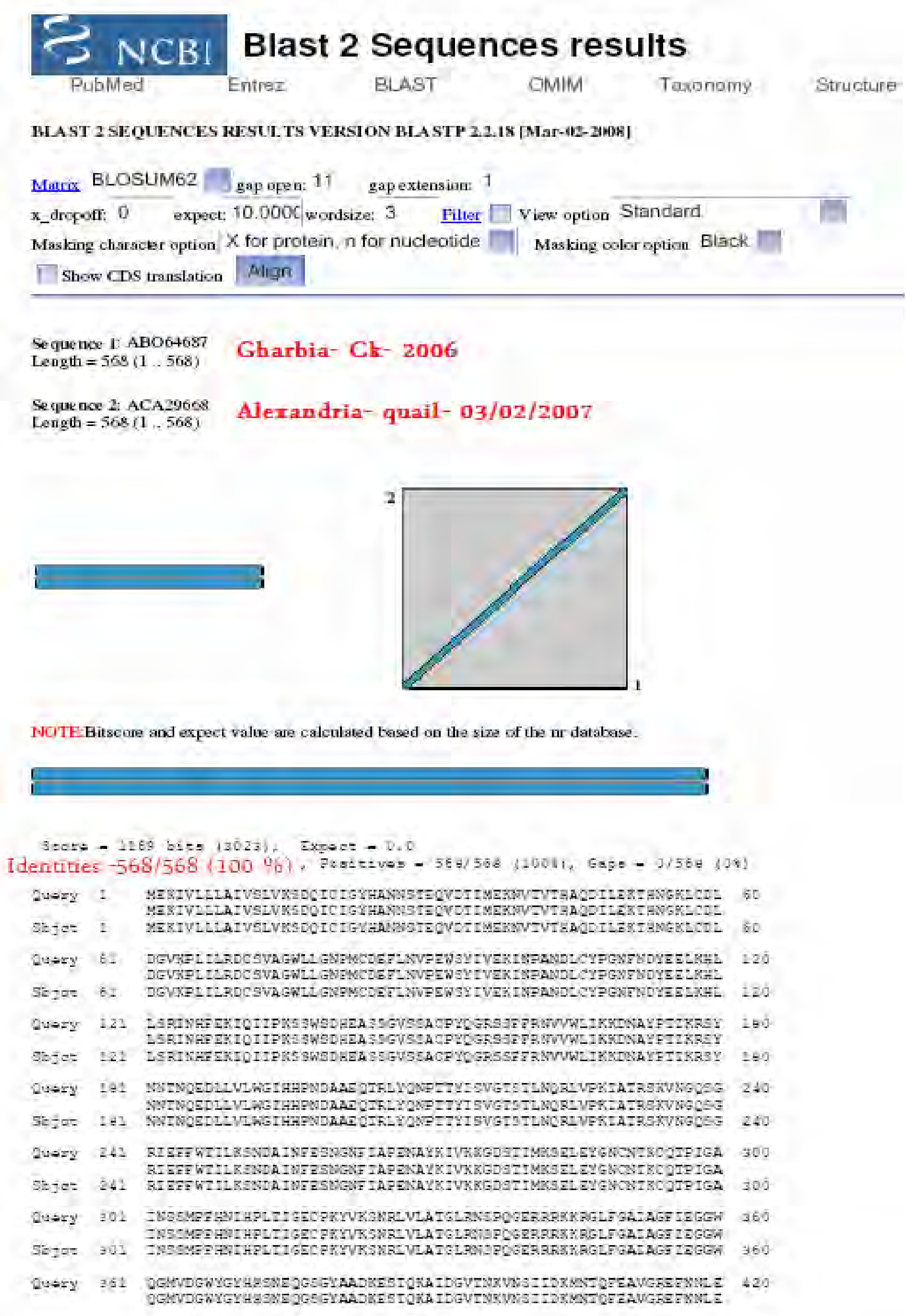
```
Sbjct  366  GSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLD  425

Query  421  VWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECME  480
            VWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECME
Sbjct  426  VWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECME  485

Query  481  SVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWM  540
            SVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWM
Sbjct  486  SVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWM  545

Query  541  CSNGSLQCR  549
            CSNGSLQCR
Sbjct  546  CSNGSLQCR  554


CPU time:     0.04 user secs.     0.04 sys. secs      0.08 total secs.
```



Blast 2 Sequences results

PubMed Entrez BLAST OMIM Taxonomy Structure

BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]

Matrix BLOSUM62 gap open: 11 gap extension: 1
x_dropoff: 0 expect: 10.000 wordsize: 3 Filter View option Standard
Masking character option X for protein, n for nucleotide Masking color option Black
Show CDS translation Align

Sequence 1: ABO64687 **Gharbia- Ck- 2006**
Length = 568 (1 .. 568)

Sequence 2: ACA29668 **Alexandria- quail- 03/02/2007**
Length = 568 (1 .. 568)

NOTE:Bitscore and expect value are calculated based on the size of the nr database.

```
 Score = 1169 bits (3023),  Expect = 0.0
Identities =568/568 (100 %), Positives = 568/568 (100%), Gaps = 0/568 (0%)

Query  1    MEKIVLLLAIVSLVKSDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDL  60
            MEKIVLLLAIVSLVKSDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDL
Sbjct  1    MEKIVLLLAIVSLVKSDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDL  60

Query  61   DGVKPLILRDCSVAGWLLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHL  120
            DGVKPLILRDCSVAGWLLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHL
Sbjct  61   DGVKPLILRDCSVAGWLLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHL  120

Query  121  LSRINHFEKIQIIPKSSWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSY  180
            LSRINHFEKIQIIPKSSWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSY
Sbjct  121  LSRINHFEKIQIIPKSSWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSY  180

Query  181  NNTNQEDLLVLWGIHHPNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSG  240
            NNTNQEDLLVLWGIHHPNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSG
Sbjct  181  NNTNQEDLLVLWGIHHPNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSG  240

Query  241  RIEFFWTILKSNDAINFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGA  300
            RIEFFWTILKSNDAINFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGA
Sbjct  241  RIEFFWTILKSNDAINFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGA  300

Query  301  INSSMPFHNIHPLTIGECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGW  360
            INSSMPFHNIHPLTIGECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGW
Sbjct  301  INSSMPFHNIHPLTIGECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGW  360

Query  361  QGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLE  420
            QGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLE
```

```
Sbjct  361  QGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLE  420

Query  421  RRIENLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELG  480
            RRIENLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELG
Sbjct  421  RRIENLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELG  480

Query  481  NGCFEFYHRCDNECMESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVA  540
            NGCFEFYHRCDNECMESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVA
Sbjct  481  NGCFEFYHRCDNECMESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVA  540

Query  541  SSLALAIMVAGLFLWMCSNGSLQCRICI  568
            SSLALAIMVAGLFLWMCSNGSLQCRICI
Sbjct  541  SSLALAIMVAGLFLWMCSNGSLQCRICI  568


CPU time:     0.04 user secs.     0.03 sys. secs      0.07 total secs.
```

NCBI **Blast 2 Sequences results**

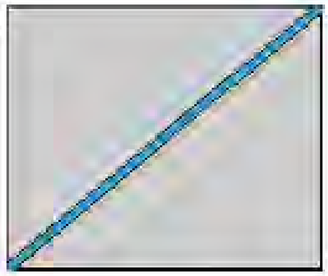
PubMed Entrez BLAST OMIM Taxonomy Structure

BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]

Matrix BLOSUM62 gap open: 11 gap extension: 1
x_dropoff: 0 expect: 10.0000 wordsize: 3 Filter View option Standard
Masking character option X for protein, n for nucleotide Masking color option Black
Show CDS translation Align

Sequence 1: ABU53968 **Sohag-Human-2007**
Length = 548 (1 .. 548)

Sequence 2: ABU53970 **Kaliobia-Human-2007**
Length = 548 (1 .. 548)



NOTE: Bitscore and expect value are calculated based on the size of the nr database.

```
 Score = 1136 bits (2938),  Expect = 0.0
Identities = 548/548 (100 %), Positives = 548/548 (100%), Gaps = 0/548 (0%)

Query  1    DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCNLDGVKPLILRDCSVAGW  60
            DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCNLDGVKPLILRDCSVAGW
Sbjct  1    DQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCNLDGVKPLILRDCSVAGW  60

Query  61   LLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHLLSRINHFEKIQIIPKN  120
            LLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHLLSRINHFEKIQIIPKN
Sbjct  61   LLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHLLSRINHFEKIQIIPKN  120

Query  121  SWSDHEASGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSYNNTNQEDLLVLWGIHHP  180
            SWSDHEASGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSYNNTNQEDLLVLWGIHHP
Sbjct  121  SWSDHEASGVSSACPYQGRSSFFRNVVWLIKKDNAYPTIKRSYNNTNQEDLLVLWGIHHP  180

Query  181  NDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRMEFFWTILKSNDAINF  240
            NDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRMEFFWTILKSNDAINF
Sbjct  181  NDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSGRMEFFWTILKSNDAINF  240

Query  241  ESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIGE  300
            ESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIGE
Sbjct  241  ESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGAINSSMPFHNIHPLTIGE  300

Query  301  CPKYVKSNRLVLATGLRNSPQGERRRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQG  360
            CPKYVKSNRLVLATGLRNSPQGERRRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQG
Sbjct  301  CPKYVKSNRLVLATGLRNSPQGERRRRKKRGLFGAIAGFIEGGWQGMVDGWYGYHHSNEQG  360

Query  361  SGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLDV  420
            SGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLDV
```

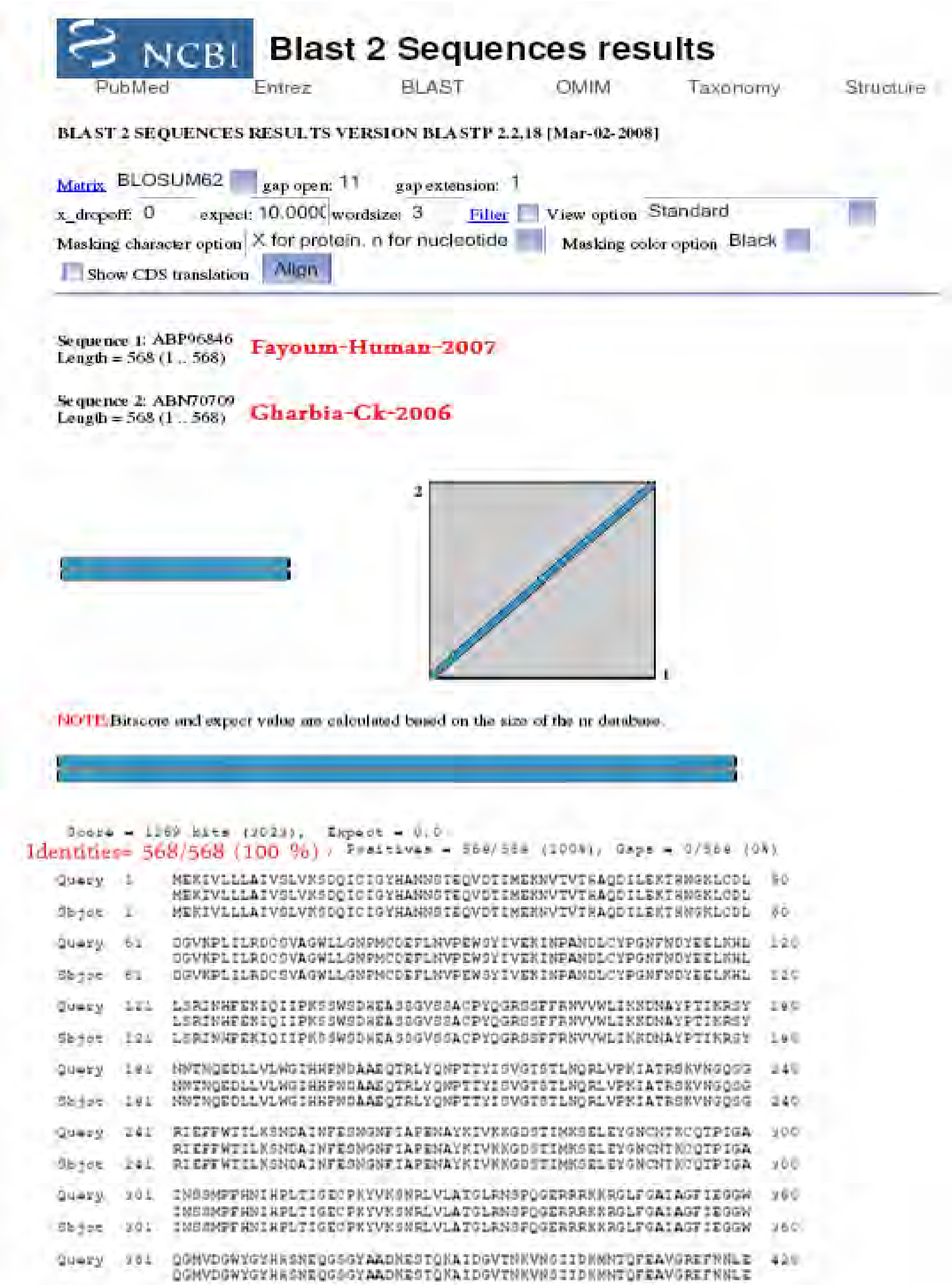
```
Sbjct  361  SGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLERRIENLNKKMEDGFLDV  420

Query  421  WTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECMES  480
            WTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECMES
Sbjct  421  WTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHRCDNECMES  480

Query  481  VRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWMC  540
            VRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWMC
Sbjct  481  VRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVASSLALAIMVAGLFLWMC  540

Query  541  SNGSLQCR  548
            SNGSLQCR
Sbjct  541  SNGSLQCR  548


CPU time:     0.05 user secs.     0.06 sys. secs      0.11 total secs.
```



NCBI
Blast 2 Sequences results
PubMed Entrez BLAST OMIM Taxonomy Structure
BLAST 2 SEQUENCES RESULTS VERSION BLASTP 2.2.18 [Mar-02-2008]
Matrix BLOSUM62 gap open: 11 gap extension: 1
x_dropoff: 0 expect: 10.0000 wordsize: 3 Filter View option Standard
Masking character option X for protein, n for nucleotide Masking color option Black
Show CDS translation Align
Sequence 1: ABP96846
Length = 568 (1 .. 568)
Fayoum-Human-2007
Sequence 2: ABN70709
Length = 568 (1 .. 568)
Gharbia-Ck-2006
2
1
NOTE: Bitscore and expect value are calculated based on the size of the nr database.
Score = 1169 bits (3023), Expect = 0.0
Identities= 568/568 (100 %), Positives = 568/568 (100%), Gaps = 0/568 (0%)
Query 1 MEKIVLLLAIVSLVKSDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDL 60
MEKIVLLLAIVSLVKSDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDL
Sbjct 1 MEKIVLLLAIVSLVKSDQICIGYHANNSTEQVDTIMEKNVTVTHAQDILEKTHNGKLCDL 60
Query 61 DGVKPLILRDCSVAGWLLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHL 120
DGVKPLILRDCSVAGWLLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHL
Sbjct 61 DGVKPLILRDCSVAGWLLGNPMCDEFLNVPEWSYIVEKINPANDLCYPGNFNDYEELKHL 120
Query 121 LSRINHFEKIQIIPKSSWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKNDAYPTIKRSY 180
LSRINHFEKIQIIPKSSWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKNDAYPTIKRSY
Sbjct 121 LSRINHFEKIQIIPKSSWSDHEASSGVSSACPYQGRSSFFRNVVWLIKKNDAYPTIKRSY 180
Query 181 NNTNQEDLLVLWGIHHPNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSG 240
NNTNQEDLLVLWGIHHPNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSG
Sbjct 181 NNTNQEDLLVLWGIHHPNDAAEQTRLYQNPTTYISVGTSTLNQRLVPKIATRSKVNGQSG 240
Query 241 RIEFFWTILKSNDAINFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGA 300
RIEFFWTILKSNDAINFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGA
Sbjct 241 RIEFFWTILKSNDAINFESNGNFIAPENAYKIVKKGDSTIMKSELEYGNCNTKCQTPIGA 300
Query 301 INSSMPFHNIHPLTIGECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGW 360
INSSMPFHNIHPLTIGECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGW
Sbjct 301 INSSMPFHNIHPLTIGECPKYVKSNRLVLATGLRNSPQGERRRKKRGLFGAIAGFIEGGW 360
Query 361 QGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLE 420
QGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLE

```
Sbjct  361  QGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGVTNKVNSIIDKMNTQFEAVGREFNNLE  420

Query  421  RRIENLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELG  480
            RRIENLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELG
Sbjct  421  RRIENLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELG  480

Query  481  NGCFEFYHRCDNECMESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVA  540
            NGCFEFYHRCDNECMESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVA
Sbjct  481  NGCFEFYHRCDNECMESVRNGTYDYPQYSEEARLKREEISGVKLESIGTYQILSIYSTVA  540

Query  541  SSLALAIMVAGLFLWMCSNGSLQCRICI  568
            SSLALAIMVAGLFLWMCSNGSLQCRICI
Sbjct  541  SSLALAIMVAGLFLWMCSNGSLQCRICI  568


CPU time:     0.04 user secs.     0.03 sys. secs      0.07 total secs.
```