Phytochemicals improve semen quality and fertility

Plants can produce phyto-chemicals with sex-enhancing powers able to stimulate the reproductive performance of birds. This results in increased fertility, improved hatchability, and a higher number of day-old chicks.

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The ultimate objective of poultry breeder management is the production of fertilised eggs. Fertility (the number of fertile eggs produced or chick hatched per parent bird) has great economical importance in poultry breeder operations as it determines the profitability of production. If an egg is not fertilised then it will not contain an embryo and will not hatch. Stress factors of all kinds compromise virtually every system of the body, producing stress chemicals, which in turn diminish the function of organs and glands. Therefore, the factors affecting fertility and hatchability are a big concern for poultry breeders. We are all aware of the medicinal values of plants. The phytochemicals from various plants demonstrate significant stress-fighting powers, which is a key to these plant's sex-enhancing abilities. Research has indicated their positive effects on the reproductive performance of birds.

Depressed reproduction

Through many years of intense genetic selection and improved nutritional management, there has been a steady and rapid increase in the growth rate of broilers produced for the meat market. A natural result of this is that present day breeders also have the propensity for extremely rapid growth, which usually has detrimental effects on reproduction.

Breeders need to be kept under ideal conditions to achieve the maximum life of flock fertility, which is imperative for good hatchability. If maximum fertility is achieved, more chicks per hen can be obtained by proper and careful hatchery operations.

Once the peak production starts declining, the percentage of infertile eggs will increase. This is the period where poultry breeders are more worried about hatchability, possibly due to the quantity and quality of semen by male chicken, which directly affects fertility and, in turn, hatchability.

In order to manage flock fertility more effectively, it is beneficial to have a good, clear understanding of the series of events which occur prior to fertilisation, as well as at the site of fertilisation in the avian egg.

Sperm formation and quality

Chicken sperm is produced within the testes, which carries the genetic material from the male. The rooster has two very large testicles within the abdominal cavity on each side of the backbone.

Sperm formation takes about 15 days. The chicken semen contains around 5 billion sperm per cc, about 25 times as much as that of a human. Once matured, and if maintained properly, the chicken will manufacture about 35,000 sperm every second of his life. The chicken's reproductive system is very sensitive to the bird's environment. Under poor conditions, the reproductive system (the testes) will dwindle, consequently affecting semen production.

Old, stale sperm is sperm that has been inseminated in the hen and stored in the storage tubules of the hen's oviduct for an extended period of time. Research has shown that old, stale sperm in the oviduct is associated with poor chick quality and early embryonic mortality. Here lies the importance of repeated artificial insemination at regular intervals (at least every three days).

Mating must occur frequently enough to ensure that relatively fresh and viable sperm are available to the hen at the time she ovulates. However, avian sperm do have an extended fertilisable life span due to the presence of sperm storage glands located in the hen's oviduct. This allows for stored sperm

Polyherbs stimulate sexual behaviour of birds resulting in more fertile eggs and chicks.

Table 1 - Minimise the damaging effects of stress on the quality and quantity of semen through the use of polyherbals

Parameter	Control Birds [Avg.]	Experimental Birds [Avg.]
Sperm Count	3.643 x 106	3.981 x 106*
Live Normal (%)	75.400	80.000**
Live Abnormal (%)	8.750	6.050**
Dead Abnormal (%)	4.600	3.000**

** Significant at 5% level*
*** Significant at 1% level*

Table 2 - The effect of herbal formulation on performance of broiler breeders

Trait	Control Group *	Treatment Group *
Hatching eggs/ hen	57.2_a	59.1_b
Chicks/ hen	52.0_a	54.0_b
Percent fertility	95.1_a	97.3_b
Mortality (%)	3.8_a	2.4_b
Feed/ hatching egg (g)	241_a	232_b
Feed/chick (g)	265_a	254_b

** Within columns, values having different subscripts are significantly different (P<0.05)*

to travel from these storage tubules to the infundibulum (the site of ovulation and fertilisation) at the appropriate time. Although the ability for sperm to be maintained in these storage sites eliminates the need for fertilisation on a daily basis, frequent mating or artificial insemination ensures the availability of fresh, high quality semen in the fertilisation process.

However, just like the males of many animal species, the fertilising potential of chicken varies, even within a flock. For example, some males are extremely fertile and create a maximum number of quality sperm; other roosters are subfertile and do not make enough good sperm. This variation in male breeder quality could be due to management, environment, nutrition, genetic make up, or the combined effect of these factors.

Sperm mobility

The term sperm mobility denotes the net movement of a sperm population against resistance at body temperature. Even though sperm cells are self-propelled DNA delivery vehicles, their self-propulsive nature is neither uniform among sperm within an ejaculate nor among males within flocks. Such variation is evident when semen quality is evaluated by sperm mobility assay. It is noteworthy that populations showing modest variation with respect to semen volume or sperm concentration often show considerable variation with respect to sperm mobility. Also notable, broiler breeder fertility is a function of sperm mobility phenotype when hens are inseminated artificially. Therefore, in terms of improving broiler breeder reproductive efficiency, sperm mobility may be a useful trait. Broiler breeder reproductive efficiency is affected by a variety of interacting variables. These include the combined effects of sexual behaviour, the effect of feeding regimens, temperature and the impact of selection for growth. Temperature, which has a profound effect on sperm cell velocity, is a critical variable affecting semen quality.

Immobile sperm cells, although viable, compromise the effectiveness of any given insemination dose. Therefore, the broiler breeder fertility is most dependant upon the function of sperm mobility.

Ovum and its formation

The hen does not produce nearly as many eggs as the rooster produces sperm, but the broiler breeder hen lays about 190-200 eggs in her total production life. Since egg formation requires more than 24 hours, even the best hens cannot lay an egg every day in succession throughout their productive life. Similar to males, some hens are more productive than others, and management has a major impact on variability among hens.

The female reproductive system is made up of two parts, namely the ovary where the egg yolk is produced, and the oviduct, which adds the white, shell membranes and shell to the yolk to form a complete egg.

The hen has only one ovary, which is on the left side of her abdomen. The ovary has several thousand ova (egg yolks) in different stages of development. If the hen is managed properly, many of these developing egg yolks will mature in about 19 days into large 35 mm yellow yolks. As the egg yolk develops it will receive water, sugars, fats, proteins, vitamins and minerals from the hen's blood. These are all required for the development of the embryo. The germinal disc is a small white dot on the perivitelline membrane surface of the yellow egg yolk. Fertilisation takes place here and embryonic development begins.

Fertilisation

Fertilisation in any animal depends on production of eggs from the female, and sperm from the male. Successful fertilisation in birds occurs following a culmination of a series of events between properly grown breeder males and females. These events are the physical act of mating or artificial insemination, sperm storage within the hen, sperm transport within the oviduct, recognition of and penetration through the wall of the ovum, and the successful joining of the male and female gamete. A problem with either sperm or egg production can decrease fertility.

After the sperm leaves the testes, they enter the epididymis where they gain the ability to swim. The sperm then enter the vas deferens where they are stored until the rooster mates with a hen.

When the egg yolk is mature, it leaves the ovary and is captured by the infundibulum. From here the fertilisation begins. When the mating process occurs normally, semen is deposited by the male in the hen's cloaca at the rate of approximately 100-200 million sperm per ejaculation. Following mating or artificial insemination, the sperm enter the hen's oviduct and are stored within sperm storage glands. Sperm travel up the oviduct to the infundibulum to join the egg yolk. Only sperm that can swim will enter these sperm storage sites. These glands

can store more than half a million sperm. Sperm can remain alive in these glands and fertilise eggs for up to 3 weeks.

A hen will have maximum fertility for only about 3-4 days after one mating. For this reason, the male-to-female ratio in a flock must be enough to ensure mating of every hen every 3 days or so.

Hundreds of sperm may enter the yolk. The more sperm that enter the yolk, the more likely the egg will be fertilised. Around 30 sperm must enter the egg near the germinal disc to insure a 95% chance of fertilisation. While it is true that only one sperm is necessary to fertilise an egg, the probability of an egg being fertilised by only one sperm reaching and penetrating it is very low.

After recognising the appropriate sites on the ovum, through enzymatic action (called an acrosome reaction), the sperm cell creates a pathway through which it passes into the ovum. This process is referred to as sperm penetration. If the sperm cell passes through the outer layer of the ovum in the germinal disc region, it gains access to the female genetic material, or pronuclei. After gaining entrance into the egg, syngamy, or joining of the male and female gametes, can occur. Following these steps, the avian egg has been successfully fertilised and after getting proper incubational conditions, embryonic development may begin.

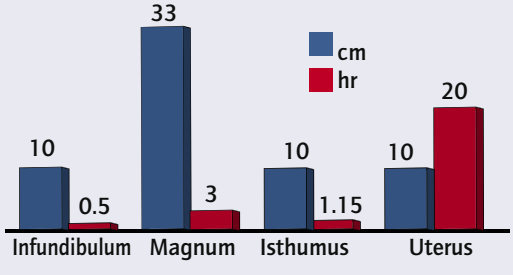
Egg formation

After about 15 minutes, the yolk leaves the infundibulum (fertilised or not) and receives the egg white, shell membranes and shell over the next several hours from the magnum, isthmus and uterus sections of the oviduct. The length of different parts of the oviduct and time taken for development of egg in it is presented in *Figure 1*.

Fertilised eggs need to be handled carefully and properly before and during incubation as embryo development is taking place.

Fertility is the primary factor resulting in fewer chicks hatched per hen housed since even the best incubators and hatchery management procedures can not produce chicks from infertile eggs.

Figure 1 - The length of different parts of the oviduct and time taken for development of egg



In addition, losses in hatch due to early dead embryos often occur concurrently with a reduction in fertility.

Management affects fertility

Poultry house management factors, such as frequency of egg collection, time of collection and care taken during on farm egg grading also has a great impact on fertility. It is directly related to the current status of the breeder flock and/or a result of lingering conditions related to the growing phase of pullet and cockerel production. Although the breeder flock itself can affect hatch, it is also often determined by the conditions the eggs are subjected to after lay, as well as during the storage, transportation and incubation processes.

Problems such as unidentified farm cracks, which results in moisture loss from the incubating egg, poor sanitation resulting in contaminated hatching eggs, or simply poor egg handling, results in weak embryos.

Fertility and embryonic mortality

Most individuals involved in reproduction of animals are familiar with the common conception that "it only takes one sperm to fertilise an egg". While this is true in mammals, it is only partly true in the avian world. While it may be true that a single sperm is all that is necessary to fertilise an avian egg, the conditions which cause low sperm numbers or single sperm activity at the site of fertilisation can cause reductions in the actual number of chicks hatched. When few sperm are available to fertilise an egg in broiler breeders there is an associated reduction in fertility, as well as an increase in early embryonic mortality. This is a common occurrence in flocks of older breeder hens or any other flock experiencing infrequent mating activity.

With advancement in age, broiler breeder reproductive performance starts to decline. In case of female's body weight and egg weight increases, egg numbers go down and hatchability drops. Also, cases of infertility, embryonic mortality, and number of cull chick's increases. In males, certain behavioural aspects, like increase in body weight, reduced mounting interest, lower libido, lower semen volume and viscosity etc., are observed.

Sex stimulating plants

A necessary component of successful breeding is maintaining male breeders with good sex desire or libido to continue to mate throughout the life of the flock. Ayurveda plants, such as Withania somnifera (Ashwagandha), Tribulus terrestris (Gokshura), Mucuna pruriens (Atmagupta), Argyreia speciosa (Brahad darak), Anacyclus pyrethrum (Akar karam) etc. are considered potent plants and are used to improve the libido, to rebuild sexual vitality and to restore proper and healthy sexual functions.

In 1995, Vanamala successfully demonstrated that the polyherbal formulation minimises the damaging effects of stress on the quality and quantity of the semen *(Table 1)*. Eight years later, Narahari observed the effect of herbal formulation on performance of broiler breeders and reported that the herbal formulation improves fertility, hatching eggs and chicks per hen, apart from reducing mortality (*Table 2*).

Upenrda *et al* (2000) studied the effect of herbal preparation in male broiler breeders and observed that there was significantly higher seminal volume per ejaculation, sperm motility, seminal fluid viscosity and semen quality of males from the group supplemented with herbal powder as compared to the control. They also indicated that improvement in hatchability, reduced infertile egg percentage as well as dead germ percentage attributed to improved semen volume, viscosity and sperm count following herbal supplementation. In 2003, Ganpule and Deshpande revealed similar observations in broiler breeders and supported the earlier findings.

The phytochemical exerts beneficial effects on gametogenic and androgenic functions of testes and are an aphrodisiac, which helps to enhance the libido of the birds. Phytochemicals also act as nervine tonic, regulating neurohormonal functions, stimulating the activity of seminiferous tubules and regulating the blood circulation level of androgen. In conclusion, breeder performance can be enhanced with the use of phytochemical rejuvenators, which ultimately results in healthier chicks. ■

References available on request.

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