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EFFECT OF THE LONG-TERM FEEDING OF *ANDROGRAPHIS PANICULATA* NEES ON REPRODUCTIVE PERFORMANCE OF PIGEONS

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ABSTRACT

This study was performed to know the effects of the long-term use of the dried powder of *A. paniculata* on reproductive attributes of pigeons, and to know whether this herbal powder can be used as a dietary supplement to pigeon. Oral administration of the low dose of this herbal powder (50mg/day) slightly enhanced the growth and reproductive capabilities of pigeon over the control. However, its higher doses (150mg & 200mg/ day) have delayed the maturation period from 180±12 to 199±16 days, reduced the number of egg cycles from 4±1to 3±0 per year, reduced the number of eggs from 8.00±2.0 to 2.25±0.11/pair/ year, extended the interval between the first and second eggs of a brood from 34±4 -37±3 to 36±3 - 39±3 hours, reduced the egg weight from 14.44±1. 2 to 13.32±1.1 g, reduced the percentage of fertile eggs from 82.7 - 82.2% to 82.2 - 74.4%, reduced the eggs' hatchability from 82.7±1. 1 to 74.4±1.4, reduced the weight gain of young squabs compared to control group, and increased the squab mortality from 39.9±2.17 to 49.7±4.17% in pigeons. These negative effects appeared even in the second year but well characterized enough to reduce the fertility of pigeons in the 3rd year. Therefore, this study concludes that this herbal powder is, although a good immunostimulant, not suited to use as a dietary supplement to pigeon.

INTRODUCTION

Andrographis paniculata Nees is a slender upright annual herb with lanceolate leaves, zig-zag panicle inflorescence, small white flowers and oblong compressed capsules (Matthew, 1991). This is astringent, anodyne, tonic, febrifuge, antiviral, anthelmintic and alexipharmic due to the presence of some bitter active principles (Ambasta, 1992). It is indigenous to the plains of India, and is called Kiryat (Hindi), Kalmegh (Bengali), Nelavembu (Tamil) and Nelavepu (Malayalam). It is used for dysentery, cholera, diabetes, consumption, influenza, bronchitis, itches, intestinal worm, insect bites, cold and fever in various traditional medicines and folk medicines throughout Asia. Experiments confirm that it is an immunostimulant to tone up both the innate immunity and acquired immunity in fishes, aquatic animals, birds, cattle and man (Puri *et al*., 1993; Sunil Kumar *et al*., 2011). Puri *et al* (1993), have shown that in chicken fed with normal diet and *A.paniculata* there has been a significant increase in the weight gain of birds.

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Nevertheless it is often feared that certain constituents of this plant may have anti-fertility effects on animals while they are fed with the powder or extract of this plant continuously (Shahid Akbar, 2011). Oral administration of the powdered stem of this plant had shown its antifertility effect on male Wistar mice (Shamsuzzoha *et al*., 1978, 1979). Chang (1987) has demonstrated that daily administration of the powder of *A. paniculata* has induced more frequent abortions than in control rabbits. When such studies were conducted in female rats by providing 2g/kg/day for six weeks, they lost their fertility at high doses (Zoha *et al*., 1989). Injection of the decoction of this plant through intraperitoneal, intramuscular, intravenous or subcutaneous rout has also induced abortions at different stages of pregnancy in female albino mice (Chang, 1987). This abortifacient effect of this decoction was corrected partly or completely by injecting progesterone or luteinizing hormone-releasing hormone, which indicates that active principles of this plant interfere with progesterone activity in female animals (Shahid Akbar, 2011). Aqueous extract of this plant has inhibited the proliferation of chorionic trophoblastic cells of human placenta *in vitro* and hence it is believed that certain constituents of this plant have abortifacient effect (Chang. 1987). Experiments with male rats had proved that daily intake of 20 mg of *A. paniculata* powder leads to infertility in them due to the inhibition of spermatogenesis, degeneration of seminiferous tubules, regression of Leydig cells, and regressive degenerative changes in the epididymis, seminal vesicle, ventral prostate, and coagulating glands (Akbarsha *et al*., 1990; Burgos *et al*., 1997; Akbarsha and Murugaian, 2000). Mkrtchyan *et al* (2005) have also proved the negative effect of *A. paniculata* in the sperm quality and fertility of rats. *A. paniculata* has been used in poultry as a dietary supplement to promote the growth of chickens and as an immunomodulant to tone up the innate immunity to resist the invasion of potential pathogens into the fowls. While pigeons were fed with powder of the shoot of this plant, it provided more protection to infections in the flocks due to its immune modulating capabilities. Nevertheless, no available report can reveal whether continuous use of this plant will affect the reproductive attributes of pigeon or not. Therefore, a long-term study was planned to know the effect of *A. paniculata* on reproductive characters of pigeons for four years and the results are presented in this paper.

MATERIALS AND METHODS

Two-months old black coloured Lahore pigeons (*Columba livia domestica*; family: Columbidae; order: Columbiformes) were chosen as the experimental birds for this study. 50 pairs of pigeons were divided into five groups each with 10 pairs and every group was grown in a separate loft of 5′ x 7′ x 3′ size. The lofts were constructed with wooden frame, steel plated roof and wire mesh floor and lateral sides. These lofts were kept at a height of 2.5′ from the ground level for reducing dampness facilitating the rapid spreading of pathogenic germs. Feed mixture (in Table 1) was given at the rate of 90 grams per pair of pigeons per day and drinking water was provided at the rate of 120 ml per pair/day. Vitamins required for the birds were provided along with the drinking water at the rate of 5ml of Vimeral® (vitamin mix)/ 1 liter water. This feed composition was maintained throughout the study period for feed uniformity in the experimental pigeon groups. Whole plant of *Andrographis paniculata* was collected locally from Kanyakumari district (India), dried under shade, then sun dried and ground into an herbal powder. Required amount of the herbal powder was fed to the pigeons by hand feeding along with some drops of water.

Thus the following groups of birds were maintained:

Group I: Normal feed only (control)
Group II: Normal feed + 50mg *A. paniculata* / day
Group III: Normal feed + 100mg *A. paniculata* / day
Group IV: Normal feed + 150mg *A. paniculata* / day
Group V: Normal feed + 200mg *A. paniculata* / day.

All the experimental groups were maintained properly for the period of three consecutive years (Jan 2012 – Dec 2015) and their squabs were transferred regularly to other lofts after attaining full flight stage (56th day). Reproductive parameters such as maturation period, number of egg cycles, length of egg cycles (interval between two consecutive laying seasons), duration between the appearance of first and second eggs, total egg production, egg weight, percentage of fertile eggs, hatching percentage, dead embryos in eggs, change in body weight of squabs at weekly intervals, and mortality and livability of squabs were recorded. Data obtained from three replicates of this experiment were subjected to one-way ANOVA, using SPSS (1997) computer software. The significant differences among the means of different dietary treatments were analysed with the Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

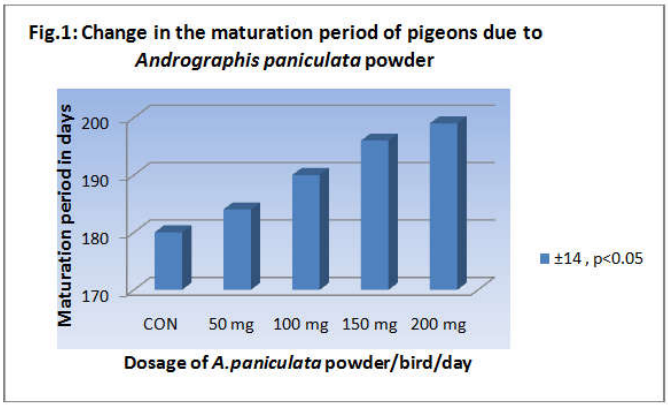
Maturation Period

Fig 1 clearly depicts that maturation period of pigeon significantly ($P<0.05$) increased with the increasing dosages of the powder of *A. paniculata* up to 200 mg/bird/day. Dietary supply of this powder had extended the maturation period to 184±14, 190±13, 196±14 and 199±16 days in response to 50mg, 100mg, 150mg and 200 mg of the herbal powder respectively instead of 180±12 days in control group. Pigeons attain sexual maturity in the 6th or 7th month (Sturtevent and Hollander, 1978; Kazal Krishna Ghosh, 2013). The results of present study agreed with the earlier reports. However, there was a considerable delay in the sexual maturity in pigeons fed with the herbal powder because at least certain constituents of *Andrographis* had partly suppressed the release of various hormones participating in the development of sex organs in pigeon.

Table 1. Composition of normal feed

Ingredients	Percentage
Wheat grains	35 %
Finger millet	15%
Pearl millet	15%
Green pea	30%
Grid*	4.97%
Vimeral ® **	0.5ml/pair

* Grid: I kg contains 100 g charcoal, 100g egg shell, 75g limestone, 150g table salt and 575g brick powder;
** Vimeral ®: 1ml contains vitamin A -12,000 IU; Vitamin B_{12} – 20 mcg; vitamin D_2 -6,000 IU; and vitamin E -40mg.



Number of Egg Cycles

Table 2 shows that in pigeons the number of egg cycles per year was significantly ($p<0.05$) affected by different dosage of *A. paniculata*. Since young birds took nearly six months to attain maturity, the egg cycle number was low in the first year.

But, in the subsequent years, birds fed with normal feeds gave 4±2egg cycles/year while those fed with the herbal powder gave 4±1 to 2±1egg cycles/year. There was a reduction of 1 -2 egg cycles in the 3rd year due to the negative effects of higher doses (150 & 200 mg/day) of the herbal powder.

Duration between Eggs

Data shows that pigeons fed with increasing doses of *Andrographis* powder had significantly ($p<0.05$) increased the duration between the laying of successive eggs of a brood compared to those fed with normal feeds (Table 4).

Table 2. Number of egg cycles of pigeons in response to different doses of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	2±0^{ns}	2±0^{ns}	2±0^{ns}	2±0^{ns}	2±0^{ns}
2nd year	4±2^{ns}	4±1^{n}	4±1^{b}	3±1^{b}	3±1^{b}
3rd year	4±2^{ns}	4±1^{a}	3±1^{a}	2±1^{a}	2±1^{b}

*Figures after ± represent standard deviation; ns = non-significance; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n=30 pairs.

Table 3. Length of egg cycle (days) of pigeons in response to different dosages of *A. paniculata*

Egg cycle (days)	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	64±3^{a}	66±4^{a}	66±4^{a}	69±4^{a}	73±4^{b}
2nd year	64±3^{a}	66±4^{a}	66±4^{a}	79±4^{b}	81±4^{b}
3rd year	66±4^{a}	68±3^{a}	70±3^{a}	84±4^{b}	90±4^{b}

*Figures after ± represent standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n=30 pairs

Table 4. Duration (hours) between the laying of successive eggs of a brood in response to different doses of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	34±4^{a}	37±4^{a}	37±3^{a}	38±3^{b}	38±3^{b}
2nd year	35±3^{a}	37±3^{a}	38±2^{a}	39±2^{b}	39±2^{a}
3rd year	36±2^{a}	38±2^{a}	40±3^{a}	41±3^{b}	42±3^{b}

*Figures after ± represent standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n=30 pairs.

Table 5. Change in the number of eggs/year in response to different doses of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	4.00±0.0^{a}	4.00±0.25^{a}	3.00±0.13^{a}	3.00±0.10^{a}	2.00±0.08^{a}
2nd year	8.00±2.0^{a}	8.50±0.18^{a}	5.50±0.0^{a}	4.25±0.0^{a}	3.50±0.13^{a}
3rd year	8.00±2.0^{a}	8.00±0.0^{a}	3.25±0.14^{a}	3.00±0.12^{a}	2.25±0.11^{a}

*Figures after ± represent standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n=30 pairs

Length of Egg Cycles

Pigeons fed with increasing doses of *Andrographis* powder had significantly ($p<0.05$) exhibited lengthened egg cycle period compared to those fed with normal feeds (Table 3). The length of egg cycle was usually increasing from 66±3 in the first year to 66±4 days in the third year, but *Andrographis* treatment had extended the duration from 66±4 to 90±4 days. Higher doses (150mg & 200 mg/day) had the maximum negative effect on the length of egg cycle in pigeons. According to Abed Al-Azeem (2005), egg cycle of healthy pigeons is within the range of 45¾ -54½ days. AbouKhashaba and Mariey (2009) had observed that dietary supplementation of 1to 5 g of vitamin and minerals premix/kg of diet had shortened the length of egg cycle from 56.62 to 45.62 days, which points out that rich nutrients had some effects on reducing the length of egg cycle in pigeons. Also, the duration of egg cycle depends on the activity of parents to nurse their squabs and warmth (Mariey, 2013). This finding clearly agrees with the reports of Mariey (2013), but there is an increase in the length of egg cycle because of some negative effects of *A. paniculata* on the metabolic activities of pigeons.

The duration between the successive eggs was usually increasing from 34±4 in the first year to 36±2 hours in the third year, but *Andrographis* treatment had delayed the duration from 37±4 to 42±3 hours. 150mg and 200 mg of *Andrographis* powder per day had shown the maximum delay in the laying of the second egg (33±3 to 42±3 hours) instead of 34±4 to 36±2 hours after the first egg. The second egg of pigeon appears about 40 hours after laying the first egg (Johnston, 1998). The second egg was laid 30-34 hours after laying the first egg of the brood (Hagg, 1991). Results of this investigation show that *Andrographis* powder has significantly delayed the laying of the second egg after the emergence of the first egg of the clutch, and that its negative effect was more in the third year compared to the first year when the growth activities are vigorous.

Number of Eggs Produced

Table 5 shows out that different doses of *Andrographis* powder had significantly ($p<0.05$) reduced the egg production compared to pigeons fed only with normal feeds. Pigeon pair fed with normal feeds had laid 4 eggs in the first year and 8±2 eggs in the subsequent years whereas those fed with *Andrographis* had laid 2-4 eggs in the first year and 2-6 eggs in the next coming years. Further, these results imply that this herbal powder had decreased the egg production every year in all the treatments, and this negative effect was the maximum at 150 and 200 mg/day in the third year. Dietary supplementation of 150 and 200 mg of this drug per day had reduced the egg productivity up to 1/3 of the total production. The clutch size of a pigeon pair is two, of which the first egg usually hatches into a male squab and the second one hatches into a female squab (Johnston, 1998). Therefore, birds provided with normal diet had produced 8-10 eggs in 4 -5 broods, but the birds which received the herbal powder produced single eggs in 2 or 3 broods every year. Reduced number of egg cycles and production of single eggs were the main reasons for low egg production in pigeons fed with the herbal powder. Certain constituents of this herbal have abortifacient effect (Chang. 1987) in female rats and antifertility effects on male rats and mice due to the inhibition of spermatogenesis, degeneration of seminiferous tubules, regression of Leydig cells, and regressive degenerative changes in the epididymis, seminal vesicle, ventral prostate, and coagulating glands (Akbarsha *et al*., 1990; Burgos *et al*., 1997; Akbarsha and Murugaian, 2000). Hence, it is clearly obvious that long term use of *A. paniculata* has decreased the egg production in pigeons.

Egg Weight

Feeding the pigeons with *Andrographis* powder had significantly ($p<0.05$) lowered egg weight of both the first eggs and the second eggs in course of time compared to the egg size of pigeons in control group (Table 6). Weight of first egg usually decreased from 14.44±1.2 g (in the first year) to 14.34±1.1g (in the third year) while the weight of the second egg habitually decreased from 14.42±1.1g (in the first year) to 14.30±1.2 g (in the third year). Andrographis powder decreased the weight of the first egg from 14.62±1.30 g to 13.36±1.1g and that of the second egg from 14.44±1.0 g to 13.32±1.1g. Reduction in egg size was observed even in the 50 mg dose of *Andrographis* and it was the maximum in the 150 and 200 mg of this drug during the 3rd year. Ibrahim and Sani (2010) found that the egg weight is 14.7cm in pigeons. According to Darwati *et al.* (2010), the egg weight ranged from 10.7 to 23.2 gm. Dietary supplementation of yeasts (Mariety, 2013) and vitamins and minerals (AbouKhashaba and Mariey, 2009) give large-sized eggs compared to control. According to Pingel and Jeroch (1997), the egg quality varies depending on the genetic traits of pigeons and nutrition provided to them. The egg size of birds is mainly determined by the volume of egg white which is in fact affected by the nutritive value of feeds consumed (Tazawa and Whittow, 2000).

Table 6. Average weight of eggs in response to different concentrations of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year					
1st egg	14.44±1. 2 ^{a}	14.62±1.30 ^{a}	14.12±1.20 ^{a}	14.02±1.21 ^{a}	14.01±1.11 ^{b}
2nd egg	14.42±1. 1 ^{a}	14.44±1. 0 ^{a}	13.61±1.30 ^{a}	13.11±1.18 ^{b}	13.12±1.16 ^{b}
2nd year					
1st egg	14.41±1. 0 ^{a}	14.42±1. 2 ^{a}	13.43±1. 2 ^{a}	13.60±1.3 ^{a}	13.61±1.2 ^{b}
2nd egg	14.37±1. 1 ^{a}	14.41±1. 2 ^{a}	13.42±1. 1 ^{b}	13.44±1. 0 ^{a}	13.42±1. 0 ^{a}
3rd year					
1st egg	14.34±1. 1 ^{a}	14.37±1. 0 ^{b}	13.33±1. 1 ^{a}	13.38±1. 1 ^{b}	13.36±1. 1 ^{b}
2nd egg	14.30±1. 2 ^{a}	14.34±1. 0 ^{a}	13.31±1. 2 ^{a}	13.35±1. 1 ^{a}	13.32±1. 1 ^{a}

*Figures after ± represent standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n=50 eggs

Table 7. Percentages of fertile eggs produced in response to different doses of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	82.7±1. 1 ^{a}	84.3±1. 3 ^{a}	81.2±1. 2 ^{a}	80.5±1. 4 ^{b}	78.3±1. 2 ^{a}
2nd year	83.1±1. 2 ^{a}	82.7±1. 5 ^{a}	79.4±1. 3 ^{a}	78.4±1. 1 ^{a}	76.6±1. 5 ^{a}
3rd year	82.2±1. 2 ^{a}	81.6 ±1. 4 ^{a}	78.2 ±1. 4 ^{a}	76.7 ±1. 2 ^{b}	74.4±1. 4 ^{b}

*Figures after ± represent standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n= 30 pairs

Table 8. Percentages of infertile eggs produced in response to different doses of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	17.3±1. 2 ^{a}	15.7±1. 3 ^{a}	14.8±1. 5 ^{a}	18.5±1. 1 ^{a}	20.6±1. 4 ^{a}
2nd year	16.9±1. 3 ^{a}	14.7±1. 5 ^{a}	18.6±1. 4 ^{b}	20.6±1. 3 ^{b}	20.6±1. 3 ^{b}
3rd year	17.0±1. 1 ^{a}	18.4 ±1. 3 ^{a}	19.8 ±1. 3 ^{a}	21.3 ±1. 2 ^{b}	21.6±1. 5 ^{b}

*Figures after ± represent standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n= 30 pairs

Table 9. Hatching percentage of fertile eggs in response to different doses of *A. paniculata*

Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	96.3±1. 2 ^{a}	94.7±1. 7 ^{a}	92.4±1. 3 ^{a}	92.3±1. 6 ^{b}	92.0±1. 3 ^{b}
2nd year	96.5±1. 3 ^{a}	94.9±1. 5 ^{a}	92.2±1. 8 ^{b}	91.4±1. 5 ^{b}	91.2±1. 1 ^{a}
3rd year	96.3±1. 3 ^{a}	94.3±1. 4 ^{b}	91.4±1. 6 ^{a}	90.3±1. 3 ^{b}	90.1±1. 6 ^{b}

*Figure after ± represents standard deviation; ^{a} = ($p<0.05$); ^{b} = ($p>0.05$); n=300 eggs.

Fatty acids profile of yolk lipids does not vary in pigeons depending on the type of nutrition (Gugolek *et al*., 2013). Therefore, it is concluded that nutrition type can alter the volume of egg white to determine the size of eggs. Certain active principles in *A. paniculata* might have some negative effects on the synthesis of egg white which led to the production of somewhat low amount of egg white in the eggs and production of smaller eggs. This negative effect might have increased with increase in the age of pigeons because of the combined effect of ageing and drug powder.

of the total laid eggs were found to be infertile because of the failure of the fusion of egg and sperm nuclei. The percentage of infertile eggs was high during the summer and winter because of extreme heat and cold (Levi, 1963). Dietary yeasts, which increase the growth and reproductive attributes, improve the quality of semen in pigeons to increase the fertility percentage of eggs (Mariety, 2005) and it is also confirmed in quail hens (Abdel- Azeem *et al*. 2005). Here, the increase in fertility percentage of egg is related to higher sexual efficiency and better semen quality of males (Mariety, 2005).

Table 10. Percentage of embryo death in response to different doses of *A. paniculata*

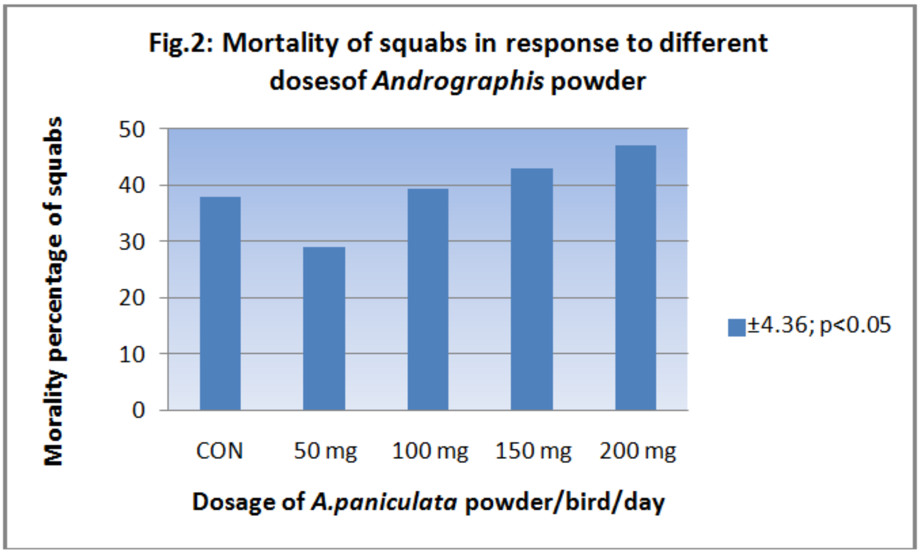
Duration	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st year	3.7±1. 3 [a]	5.3±1. 2 [a]	6.4±1. 1 [a]	7.7±1. 3 [a]	8.0±1. 3 [a]
2nd year	3.5±1. 2 [a]	5.1±1. 4 [a]	7.6±1. 2 [a]	8.6±1. 3 [a]	8.8±1. 4 [a]
3rd year	3.3±1. 1 [a]	5.7±1. 4 [a]	8.6±1. 3 [a]	9.7±1. 2 [a]	9.9±1. 2 [a]

*Figure after ± represents standard deviation; [a] = ($p<0.05$); [b] = ($p>0.05$); n=300 eggs.

Table 11. Weight changes of squabs in response to different dosage of *Andrographis paniculata*

Time	Normal feed (Control)	Normal feed + 50mg of *A.paniculata*	Normal feed + 100mg of *A.paniculata*	Normal feed + 150mg of *A.paniculata*	Normal feed + 200mg of *A.paniculata*
1st day	19±2.12 [a]	19±2.18 [b]	19.12±3.29 [a]	19.02±2.18 [b]	19.02±2.18 [b]
7th day	99±8.21[a]	100±8.26[a]	96±9.28 [a]	90±9. 82 [b]	93±10. 22 [b]
14th day	182±11.29 [a]	182±12.61[a]	164±12.29 [a]	132±12.18 [b]	118±12.10 [b]
21st day	304±9.54 [a]	305±7.74 [a]	285±7.62 [a]	245±10.60 [b]	228±11.28 [b]
28th day	353±11.61 [a]	366±8.67 [b]	326±10.11 [b]	296±10.16 [b]	278±11.08 [b]
35th day	452±12.29 [a]	454±11.42[a]	388±10.40 [a]	328±12.48 [a]	300±10.31[b]
42nd day	473±10.61 [a]	476±8.69 [a]	396±8.69 [a]	354±10.29 [b]	311±13.22[b]
49th day	425±12 [a]	423±10.6 [a]	343±8. 5 [a]	312±10.42 [a]	292±10.6 [a]
56th day	312±12.4 [a]	318±42.6 [a]	288±8.5 [b]	269±8.6 [a]	247±10.7 [b]

*Figure after ± represents standard deviation; [a] = ($p<0.05$); [b] = ($p>0.05$); n=25 squabs in each treatment



Percentage of Fertile and Infertile Eggs

The percentage of fertile eggs laid by pigeons fed with *Andrographis* powder was significantly ($P<0.05$) reduced compared to that in the pigeons of control group (Table 7). *Andrographis* treatment has decreased the fertility percentage up to 81.6 – 74.4% instead of 82.7 - 82.2% in control. Reduction in fertility percentage was observed even in the 50 mg dose of *Andrographis* (3rd year) and there was the maximum reduction of egg fertility in the 150 and 200 mg of this drug in the 3rd year. Meleg (1997) reported that 4.6 – 6.3%

Akbarsha, *et al*., (1990), Burgos *et al*., (1997), Akbarsha and Murugaian (2000) and Mkrtchyan *et al* (2005) have already proved the negative effect of *A. paniculata* in the sperm quality and fertility of rats and mice. Therefore, it is concluded that this herbal powder has reduced the fertility of eggs in pigeon, and that this negative effect increases with age of the pigeons. As a consequence, the number of infertile eggs had increased significantly ($p<0.05$) in pigeons fed with *Andrographis* powder and this effect was high at 150 and 200mg/ day (Table 8).

Hatching Percentage and Embryo Death

Powder of *A. paniculata* had significantly ($p<0.05$) reduced the hatching percentage of fertile eggs of pigeons (Table 9). In the control group, there was no significant change in the hatchability of eggs (96.3%) during the course of experiment. But, dietary supply of the herbal powder lowered the egg hatchability (94.9 – 90.1%) and this effect was found to be the maximum at 150 and 200 mg /day. Hatching percentage is within the range of 59.68 - 63.69% in pigeons and is low in spring and high during the summer (Meleg, 1997). Darwati *et al*. (2010) observed 77% hatchability in pigeon eggs. Probiotic yeasts, which increase the growth and reproductive attributes, increase the hatchability of eggs in pigeon (Mariety, 2005). Dietary supply of vitamins and minerals has also improved the hatchability of the eggs of quail hens (Abdel- Azeem *et al*., 2005). Therefore, it is believed that nutritious feeds can in general improve the hatchability of eggs.

In the present study, supply of this herbal powder had decreased the hatchability of fertile eggs because of the mild antagonistic effects of certain active principles on the early embryo development in the eggs. This idea agrees with Chang (1987) who had induced abortions at different stages of pregnancy in female albino mice by injecting the decoction of *A.paniculata* through intramuscular or subcutaneous rout. Owing to the slight abortive effect of this herbal powder, the percentage of embryo death in the eggs increased from 5.3 (1st year) to 9.9 (3rd year) at the higher (150 & 200 mg/day) concentrations (Table10). Meleg (1997) reported embryo death as high as 16-19% of eggs during incubation in poorly managed lofts, but Mariety (2005) reported only 2-3% of eggs with dead embryos when pigeons were fed with yeast supplementation. Here, embryo death was more in the present study than the previous reports because of defects in the early embryo development.

Change in Body Weight of Squabs

Results in table (11) indicate that there were significant ($p<0.05$) differences in the body weight of squabs on the 1st, 7th, 14th, 21st, 35th, 42nd, 49th and 56th days both in the control group and pigeons fed with 50mg, 100mg, 150mg and 200 mg of herbal powder per day. When pigeons were fed with normal feeds, the weight of squabs increased from 19±2.12 (1st day) to 473±10.61g (42nd day) and then declined to 312±12.4 g (56th day). Supply of 50mg herbal powder per day had slightly increased the weights of squabs at all time points of the experiment but higher doses (100, 150 and 200mg/day) strongly reduced the weight of the squabs. The maximum weight of squabs on the 42nd day was within the range of 396±8.69 (100mg/day) to 311±13.22 (200mg/day) instead of 473±10.61g (control). The weight of squabs at full flight stage (56th day) was ranged from 288±8.5 g (100mg/day) to 247±10.7g (400mg/day) instead of 312±12.4g in the control. Levi (1954), Bokhari (1994) and Sales and Janssens (2003) have reported that in the first six or seven days, the body of squabs seems to be doubled in size and the squabs have reached the peak of its growth for size and weight in 26-28 days. The results of weight change in the control group are in the same line of reports made by Levi (1954) and Bokhari (1994). Dietary supplements that promote the growth and reproductive attributes of pigeons have enhanced the growth and body weight gain in squabs (Mariey, 2013; Saxena *et al*., 2008). This herbal powder, although favouring the growth at 50mg/day, had reduced the body weight of squabs at higher doses (100, 150 and 200mg/day) due to its activity of blocking various metabolic pathways at different levels.

Mortality Percentage of Squabs

Mortality rate of squabs before full-flight stage (56 days) was significantly ($p<0.05$) affected by increasing dosage of *Andrographis* powder compared to squabs of the control group (Fig.2). The mortality percentage of young squabs increased from 31.4±2.42 to 49.7±4.17 in the herbal treated groups instead of 39.9±2.17 in control group. In pigeons early mortality of squab is relatively higher than the mortality after flight stage (Meleg, 1997). Feed supplements that promote the growth and reproductive attributes of pigeons have enhanced the survivability of squabs (Mariey, 2013). Visual examination of the squabs showed that the parents fed with *Andrographis* powder fed only a small volume of crop milks compared to the squabs in the control group, which implied that this herbal powder has reduced the level of secretion of crop milk from parents at higher doses (150 and 200mg/day) by blocking the vital metabolic activities, removing the beneficial microflora of intestine and reducing the rate of normal physiological activities of squabs. Therefore, squab mortality in the experimental groups are little higher than that in the control group.

Conclusions

From the above data, it can be concluded that long term use of the dried powder of *A. paniculata* has delayed the maturation period, reduced the number of egg cycles per year, number of eggs per year, extended the interval between the first and second eggs of a brood, reduced percentage of fertile eggs, the size and weight of eggs, hatchability and weight gain of young squabs, and increased the squab mortality in pigeons. Nevertheless, this herbal powder is a good immunostimulant and antiviral drug to reduce infections. Low dosage (50mg/day) of this herbal powder did not cause any ill effect in reproductive parameters of pigeons but its higher doses adversely affect their reproductive characteristics. Since this herbal powder is causing reproductive stress in pigeons, it should not be recommended as a dietary supplement to pigeons and related birds and we suggest that it may be given orally at a dosage of 100mg for 1or 3 days for disease control.

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