Effect of serial hatching and season on egg production and hatchability of non-descript indigenous Xhosa chicken ecotype

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Abstract
The objective of the current study was to determine the effect of serial hatching on egg production parameters and hatchability of the non-descript indigenous Xhosa chicken ecotype. Additionally, the effect of season on egg production parameters over 4 seasons was also recorded. The seasonal evaluation included the period of serial hatching to which the experimental hens were subjected. Eighteen hens from non-descript indigenous chicken ecotype were used in the trial and kept on the farm of a developing farmer involved in indigenous chicken production. The hens were randomly allocated to an experimental (n=9) and control (n=9) group and mated. After mating, the hens in both groups were allowed to lay eggs which were collected on a daily basis. Once they became broody, the hens in the control group were allowed to brood, hatch and raise their chicks while the hens in the experimental group were subjected to a period of serial hatching. Day-old chicks were removed during twilight and replaced by 10 more eggs for each hen for three consecutive serial hatching periods. The following parameters were recorded in both groups for the period before serial hatching – days from mating to lay (ML); days from mating to brooding (MB); days from lay to brooding (LB); days of egg production (DP) and days of no production (DNP). The same parameters were recorded after the period of serial hatching and in addition, the hatchability of eggs from both groups was compared after serial hatching. As far as seasonal variation was concerned, days of production (DP); days of no production (DNP) and brooding days (BR) were considered. There were no significant differences between the experimental and control groups in the measured production parameters in the period before and after serial hatching, except for egg fertility (hatchability), which was significantly higher (p<0.05) in the experimental group after serial hatching. However, there were significant differences (p<0.05) within and between groups when production parameters were compared over seasons. The results indicate that serial hatching has no negative effect on indigenous chicken production. However, seasonal differences in egg production occurred in indigenous Xhosa chickens.

Keywords: Brooding, egg laying, days of production, indigenous hens, season, fertility.
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Introduction
Communal poultry farming in the Eastern Cape Province is dominated by the indigenous ecotype which varies widely in body size, conformation, plumage colour and other characteristics (Dyubele et al., 2010). They are normally kept as a flock of chickens under free-range conditions with no proper feeding management and selection for breeding purposes. The rearing of poultry provides an excellent opportunity for gainful employment to members of rural communities (Mandal et al., 2006). Indigenous chickens form an important part of family life and play important cultural roles such as traditional healer activities (Alders et al., 2007). They are a valuable source of energy and protein which helps to cover the nutritional needs of the rural population (Sonaiya, 2007). Additionally, it is a significant source of income (Kalita et al., 2004). They are generally preferred over commercial chickens because of their pigmentation, organoleptic qualities (taste and flavour), leanness and suitability for special activities such as traditional ceremonies (Ssewannyana et al., 2001).

However, indigenous chicken ecotypes are characterized by poor growth rate thus affecting the production cost resulting in low returns when compared to commercial breeds (Jaturasitha et al., 2008). Serial hatching involves hens being used to sit on eggs continuously for two or more hatching periods by removing chicks every time they hatch and replacing them with new eggs (Ondwasy et al., 2006).
Serial hatching is, however, not commonly practised in most communal areas even though it can improve the number of chicks produced (Kugonza et al., 2012).

Practising serial hatching will ensure chick production every 21 days thus enhancing the increase in flock numbers which in turn will create economic opportunities. Several studies have been done on indigenous chicken production in South Africa. Nyoni and Masika (2012), conducted research on village chicken production practices in the Amatola Basin of the Eastern Cape Province, South Africa; while Chulayo et al. (2011), did research on the effect of some medicinal plants on consumer sensory characteristics of village chicken meat. However, no research has been done on the effect of serial hatching and season on the performance of this specific indigenous chicken ecotype.

Materials and methods

Study site

The study was conducted on the farm “Gwatyu” situated in the Chris Hani district municipality, Eastern Cape. The farm falls under the Ennoch Mgijima local municipality. The dominating livestock species in the area are cattle and goats as well as a few farmers that produce indigenous chickens, serving a lucrative local market.

Animal management

Eighteen hens from non-descript indigenous chicken ecotype were used in the trial and kept on the farm of a developing farmer involved in indigenous chicken production. The hens were randomly allocated to an experimental (n=9) and control (n=9) group and mated. After mating, the hens in both groups were allowed to lay eggs which were collected on a daily basis. Once they became broody, the hens in the control group were allowed to brood, hatch and raise their chicks while the hens in the experimental group were subjected to a period of serial hatching. Day-old chicks were removed during twilight and replaced by 10 more eggs for each hen for three consecutive serial hatching periods.

Both groups had free access to feed and water under free ranging conditions. In addition to that, both groups were fed the same quantity of whole maize twice each day in the morning and afternoon. After the third group of day old chicks hatched, both groups of hens were exposed to the cock again for mating. All hens were evaluated over a period of a year with all seasons included. The serial hatching period for the experimental hens was included in this period and formed part of the total seasonal evaluation.

Measurements

Determination of egg production parameters before and after serial hatching

The following egg production parameters were recorded in both groups for the period before serial hatching – days from mating to lay (ML); days from mating to brooding (MB); days from lay to brooding (LB); days of egg production (DP) and days of no production (DNP). The same parameters were recorded after the period of serial hatching. Eggs laid were collected and identified for each hen accordingly labelled on the shell with a pencil.

Determination of Hatchability after serial hatching

Hatchability of the eggs was measured after serial hatching only. Eggs were collected during this period from both the experimental and the control groups and hatchability directly compared. When they became broody; each hen was provided with ten eggs from her specific group; collected during the period after serial hatching, to incubate. Hatchability of the eggs was determined as the proportion of eggs hatching to the total number of eggs incubated.

Seasonal performance over period of a year

Hen performance was monitored over four seasons of the year. As far as seasonal variation was concerned, days of production (DP); days of no production (DNP) and brooding days (BR) were considered. The serial hatching period was included in the seasonal evaluation.

Statistical Analysis

The descriptive statistics and ANOVA modules of Statistica 13.2 (Statsoft) were used for calculating means and standard deviations as well as analysis of variance between dependant variables.
Results and discussion

The comparison of production parameters before and after serial hatching is presented in Table 1 and Table 2 respectively. There were no significant differences in the measured production parameters except for egg fertility which was measured only after serial hatching. There were some differences in the other measured production parameters and especially after serial hatching, the experimental group performed slightly better when mating to laying (ML), mating to brooding (MB) and days of production were concerned. However, these differences were statistically not significant. Serial hatching has been shown to have no negative effect on the measured production parameters.

This is an indication that the use of hens for serial hatching as a way of accelerating the increase of population size (Kugonza et al., 2012, does not impact negatively on the breeding stock. This practise could, rather improve performance subsequent to the period of serial hatching (Roothaert et al., 2011). Moreover; the experimental group also recorded a higher number of eggs produced than the control group after serial hatching. The increase in number of eggs laid by the experimental group could be attributed to the break that hens had during brooding.

There was a significant difference (p<0.05) in the fertility of the eggs between the treatment group and the control group. The experimental group had higher number of fertile eggs at a mean value of 9.22±1.09 as compared to 6.43±0.98 of the control group. Despite the fact that cock fertility could have had an effect on egg fertility, the better egg fertility in the treatment group could be an indication of the beneficial effect of the resting period.

Table 1 Hen performance before serial hatching

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental (Mean ±STD)</th>
<th>Control (Mean ±STD)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>65.0 ± 74.8</td>
<td>76 ± 67.4</td>
<td>NS</td>
</tr>
<tr>
<td>MB</td>
<td>209.1 ± 44.3</td>
<td>207.6 ± 43.4</td>
<td>NS</td>
</tr>
<tr>
<td>LB</td>
<td>144.1 ± 89.9</td>
<td>131.6 ± 667.6</td>
<td>NS</td>
</tr>
<tr>
<td>DP</td>
<td>21.1 ± 11.9</td>
<td>25.2 ± 14.1</td>
<td>NS</td>
</tr>
<tr>
<td>DNP</td>
<td>175.1 ± 43.1</td>
<td>171.5 ± 33.0</td>
<td>NS</td>
</tr>
</tbody>
</table>

ML=mating to lay, MB=Mating to brood, LB=Lay to brood, DP=Days of prod., DNP=Days no prod., NS=Not Significant

Table 2 Hen performance after serial hatching

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental (Mean ±STD)</th>
<th>Control (Mean ±STD)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>16.4 ± 10.5</td>
<td>22.4 ± 1.5</td>
<td>NS</td>
</tr>
<tr>
<td>MB</td>
<td>56.9 ± 37.7</td>
<td>59.1 ± 7.5</td>
<td>NS</td>
</tr>
<tr>
<td>LB</td>
<td>40.4 ± 31.7</td>
<td>36.7 ± 7.9</td>
<td>NS</td>
</tr>
<tr>
<td>DP</td>
<td>20.4 ± 11.4</td>
<td>13.9 ± 3.3</td>
<td>NS</td>
</tr>
<tr>
<td>DNP</td>
<td>36.9 ± 26.8</td>
<td>25.3 ± 7.8</td>
<td>NS</td>
</tr>
<tr>
<td>Fertility</td>
<td>9.22 ± 1.1</td>
<td>6.4 ± 1.0</td>
<td>*</td>
</tr>
</tbody>
</table>

ML=mating to lay, MB=Mating to brood, LB=Lay to brood, DP=Days of prod, DNP=Days no production, NS=Not Significant, *= significant difference (p<0.05)

The comparison in seasonal performance within and between groups is depicted in Table 3. Days of production in experimental hens were similar in summer and spring but differed significantly (p<0.05) from autumn and winter. There was no significant difference between autumn and winter for days of production. Days of production in control hens followed the same trend. Experimental hens showed the highest number of days of production in summer where control hens had highest number of days of production in spring.
This could be attributed to the fact that experimental hens that became broody in late winter and early spring were used for serial hatching and did not have an equal opportunity to lay eggs as compared to the control hens. This also supported by the fact that the experimental hens have shown the highest number of brooding days in spring whereas the control hens had more brooding days in summer.

Days of no production (DNP) in experimental hens was significantly lower (p<0.05) in summer and spring as compared to autumn and winter. There was no significant difference between autumn and winter as far as days of no production was concerned. Days of no production followed more or less the same trend in the control group except for the fact that there was also a significant difference (p<0.05) between summer and spring.

Days of brooding (BR) was significantly higher (p<0.05) in summer and spring as compared to autumn and winter for both experimental and control groups. There was no difference in days of brooding between autumn and winter for both groups. These results suggest that indigenous hens spent most time in summer and spring on production activities such as laying eggs and brooding.

This could be attributed to shorter days in autumn and winter which may negatively affected the oestrus cycle in hens (Guobadia, 1997; Okoro et al., 2017). This also means that hens can be fed for maintenance rather than production during this period. Autumn and winter season can be utilised to minimise production cost through partial feed restriction in hens with greater reliance on scavenging.

| Table 3 Variables across four seasons from experimental and control groups |
|-----------------|-----------|-----------|-----------|-----------|-----------|
| Variable        | DP        | DNP       | BR        |
| Group Season    | Exp       | Ctrl      | Exp       | Ctrl      | Exp       | Ctrl      |
| Autumn          | 2.7 ± 2.3b| 2.3 ± 3.1b| *72.4 ± 2.3b| *79.4 ± 3.8b| 0 ± 0.0b  | 1.3 ± 3.4b |
| Winter          | 6.7 ± 5.8b| 3.7 ± 4.8b| 73.3 ± 23.4b| 80.3 ± 7.7b| 6.6 ± 13.2b| 8 ± 10.2b |
| Spring          | 14.9 ± 5.8a| 20 ± 5.9a| 38.9 ± 16.6a| 51.7 ± 4.6c| *38.6 ± 18.2a| *20 ± 4.1a |
| Summer          | 18.9 ± 7.8a| 11.9 ± 9.9a| 34.7 ± 5.0a| 32.6 ± 6.9a| *33.8 ± 8.5a| *22.2 ± 4.5a |

DP = days of production, DNP = days of no production, BR = brooding days, Exp = experimental, Ctrl = control, Values within columns with different superscripts (b,c) differ significantly (p<0.05), Values between columns and within rows with asterisks (*) differ significantly (p<0.05)

There was no significant difference in production parameters between experimental and control hens over all four seasons except for days of no production (autumn); brooding days (spring) and brooding days summer (p<0.05). The days of no production (DNP) (72.4 ± 2.3) for the experimental groups was significantly lower than the days of no production for the control group (79.4 ± 3.8) in autumn. Days of brooding was significantly higher in the experimental group for spring (38.6 ± 18.2) vs. (20.0 ± 4.1) in the control. The same trend was established for summer where the days of brooding for experimental hens (33.8 ± 8.5) was significantly higher than the control (22.2 ± 4.5). These results indicate that use of hens for serial hatching actually does not negatively affect the productivity of the hens across all seasons and rather improve productivity in autumn through reduced days of no production.

The results for brooding days in spring and summer indicate that experimental hens have spent more days brooding in these two seasons when compared to control hens. This could be attributed to the fact that the experimental hens were used for serial hatching. These results have shown that the egg production of indigenous hens is affected by season. Spring and summer were reported to be more productive while autumn and winter seemed to be the least productive seasons (Geng et al., 2018)

Conclusion

There was no effect of serial hatching on hen performance except for a significantly positive effect on egg fertility. There were some significant differences observed in production parameters (days of production, days of no production and brooding days) across all four seasons for both experimental and control hens when compared within groups.

However, most of the production parameters had shown no significant differences when experimental hens were compared to control hens (between groups) over seasons; except for days of no production (autumn) and brooding days (spring and summer). Serial hatching does not negatively affect indigenous hen production. The seasonal pattern in production can potentially be utilized by farmers to adjust management practices and to feed accordingly.

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Author’s contributions
Conception: SN and JMR; Design: SN and JMR; Data collection and analysis: SN, JMR and GN; Critical revision: JMR; Critical revision and final approval of version to be published: all authors.

References