A CLINICAL TRIAL TO ASSESS THE EFFECTIVENESS OF A DECOCTION IN REDUCING CHICKEN MORTALITY DURING THE NEWCASTLE DISEASE PERIOD IN THE SAVANNA REGION OF GHANA

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ABSTRACT

Farmers in Ghana often practise poultry farming to compensate for poor crop harvests, with farmers using innovations that have not been scientifically validated. A clinical trial was therefore done to assess the effectiveness of Bombax costatum (Silk cotton tree) and Evolvulus alsinoides (Dwarf Morning Glory) as a decoction to control Newcastle disease (NCD) in chickens. Four neighbouring communities were randomly selected and assigned to control and treatment. In each community, approximately 20 farmers with roughly 40 chickens each were selected and assigned to the treatment chosen for the community. The decoction was given to the poultry on treatment whereas farmers on control were allowed to use their normal practice. The Generalized Linear Model was used to compare the survival rates between communities, the gender of farmers and treatments at a 5% significance level after fitting observed survival rates to a model and using the Student Newman Keuls test to separate the means. Results indicated that the treatment communities recorded a lower chick mortality rate (17%) compared with the control communities (87%) (P<0.05). While few additions (20%) in the form of new hatches were observed in the control communities, significantly more hatches (74%) were observed in the treatment community (P<0.05). Twelve per cent of the growers, on treatment died compared with 67% on control (P<0.05). Again, offtake was significantly higher in the control group compared with the treatment group (P<0.05). More of the adult chickens on control died (34%) compared with those on treatment (4%) (P<0.05). There was also more offtake of adult chickens in the control group (10%) compared with the treatment group (2%) (P<0.05). The decoction helped to reduce the incidence of disease during the NCD period. Studies are needed to ascertain the type of effect the decoction may have on the NCD virus.

Keywords: *Local chickens, poultry diseases, traditional medicine*

INTRODUCTION

About 52% of the Ghanaian labour force is engaged in agriculture (FAO, 2023). Most of these people practise mixed farming so that they can depend more on livestock in times of poor crop harvest. On the other hand, where harvests are good, some farm produce may be sold, and the proceeds used to buy livestock for rearing. Mixed farming is not without challenges, and farmers are constantly seeking solutions to such problems. Some of the innovations used by these farmers, although not scientifically validated (Guěye, 2002), have been adopted by small-scale farmers and appear to make them better off.

Farmers in the Volta Region of Ghana use Mangifera indica and Gymnosporia senegalensis to alleviate symptoms of Newcastle disease (Boakye et al., 2024). In a study by Aremu et al (2022), they realised that many African farmers used various species of Aloe to treat Newcastle disease. Farmers make these interventions despite vaccines being available to control mortality due to Newcastle disease (Boasiako et al., 2022).

An investigation of how local farmers have displayed tremendous tenacity and have survived intense hardships including drought and the Newcastle Disease (NCD) may reveal some interesting findings that may be worth subjecting to further investigation and, if found effective, worth sharing with other farmers. According to Njagi et al. (2010), the conditions that favoured the outbreak of Newcastle disease were a warm season, low rainfall, a savannah-type environment and medium altitude (760 m). Three categories of the virus have been identified. They are the lentogenic, mesogenic, and velogenic types that result in different clinical forms of the disease (Amarasinghe et al., 2017). Appiah et al. (2020) observed that chickens kept under the extensive system of production had a higher incidence of the Newcastle disease than those kept under the intensive system. Focus on what farmers do also has the advantage of reliance on their resources as opposed to external inputs which have the potential of increasing the vulnerability of these farmers. An interest in what farmers practise may reveal which practices may be harmful and which may be useful. This project aimed to assess the effectiveness of an ethnoveterinary intervention that used the bark of *Bombax costatum* (Silk cotton tree) and *Evolvulus alsinoides* (Dwarf morning glory) in a decoction for controlling NCD in chickens.

MATERIALS AND METHODS

Study location

The study was done in the East Gonja District of the Savanna Region of Ghana. The Savanna Region is characterised by Guinea Savanna vegetation. The prevailing climatic conditions are rainfall for half the year, lasting from May to October, with the remaining period being very dry and cold for the first three months and dry and hot for the remaining three months.

The area is characterised by extensive shallow sandy loams that often overlie impenetrable laterite. This milieu supports mostly small landholdings of low input-output farming systems with low yields and consequent household food and nutritional insecurity (Wood, 2013). Major problems faced by farmers are declining soil fertility, declining crop yields and a high livestock mortality rate largely due to continuous cropping, deforestation and livestock diseases. Veterinary Services and farmers have reported the incidence of NCD as high, and occurring every year, particularly in the dry season (December to May). The case fatality rate may be around 70% and the level of incidence is fairly high (Appiah et al. 2020).

The study design

The project began in March and ended on April 25, 2021. A Completely Randomized Design (CRD) was adopted given the study objectives. Four neighbouring communities that were at least over a kilometre from each other but within a diameter of 4 km (circumference = 12.57 km) were randomly assigned to two treatments, namely control and treatment. Daboashie and Dakpemyili communities were randomly chosen to be the control communities while Jangyili and Daashei became the treatment communities. This method minimised contamination and spill-over effects. If both treatments were tested in each community, it would allow birds assigned to control to have access to the treatment, because the free-range system practised by the farmers allows birds to have access to their neighbour's drinking troughs.

Within each community, approximately 20 farmers with roughly 40 chickens each were randomly chosen from a list of about equal numbers of men and women. These farmers reported that about 60% of their chickens showed signs and symptoms of NCD at the time of the experiment. The signs and symptoms included torticollis, circling, tremors, paralysis, sneezing, egestion of greenish watery diarrhoea, loss of appetite and respiratory distress.

Procedure

Preparation and application of treatments

A herbal preparation from *Bombax costatum* (Silk cotton tree) and *Evolvulus alsinoides* (Dwarf Morning Glory) was produced by a local farmer innovator for the prevention and treatment of NCD. The decoction was given to the entire household flock to consume for four continuous days if there were no sick chickens in the flock or three continuous days if there were sick chickens. Sick chickens included any chickens which showed signs and symptoms of lethargy, loss of appetite or undesirable changes in appearance. For sick flocks, the water trough was washed every third day. The administration of the infusion was repeated until the owner was satisfied that their birds had recovered. The repeat dose was also done for three or four days. Where it was required, the treatment was repeated for a total of nine (9) days for sick birds and 12 days when used as a preventive measure. The innovator assumed that there would be more contamination of decoctions patronized by sick chickens as compared to decoctions given to healthy birds hence his strategy to replace the decoction for sick chickens every three days and four days for healthy chickens.

Sick and weak birds with a poor appetite were drenched, while birds with a good appetite consumed the decoction by themselves. Farmers in the control group were allowed to use their normal practice which consisted of administering conventional antibiotics and infusions from the bark of the mahogany tree or an old dry cell.

Data collection

Experimental farmers' initial numbers of chickens were categorised into chicks, growers and adults and were recorded. Chicks were those that were still under the protection of mother hens and usually less than two months old while growers were those chickens that were fending for themselves up to the period when the females began to lay eggs. Adult chickens were those that had ever laid eggs or were in that age category above 6 months old and their male counterparts. Data was recorded every four days on the number of sick chickens, deaths, offtake and new additions. The new additions were invariably the result of new hatches to farmers' flocks. The farmers were purposively categorised into treatment and control groups, by gender and by four age categories namely 20 to 30 years old, 31 to 40 years old, 41 to 50 years old and above 50 years old. Enumerators assigned and equipped with data collection templates interviewed the experimental farmers.

Data Analysis

Morbidity rate

The mean morbidity rate was determined for each community by expressing the total number of sick chickens per farmer as a percentage of the total numbers belonging to that farmer and finding the average for all experimental farmers in the community.

Mortality rate

Mean mortality rates per community were determined by expressing the total numbers dead per farmer as a percentage of total numbers owned by that farmer and computing the average for the experimental farmers in the community. The survival rate was equal to one hundred per cent minus the mortality rate.

Chicken numbers

Mean initial numbers of chickens per farmer in a community were determined by adding the initial number of experimental chickens in the community and dividing it by the number of experimental farmers in that community. Mean final numbers per experimental farmer per community were also determined by adding the number of chickens at the end of the experiment divided by the number of experimental farmers per the respective community.

New additions rate

The mean new additions rate was determined per community as the total number of additions, mainly as hatches of chicks, expressed as a percentage of the total initial numbers per community.

Offtake rates

Offtake rates were calculated per experimental farmer per community as the total numbers sold, slaughtered, used for dowry and given out as gifts expressed as a percentage of the respective initial numbers owned by that farmer, summed for all experimental farmers in the community and divided by the corresponding number of experimental farmers in the community.

Statistical analysis

The following Excel formula was used to transform the chicken survival rates before the statistical analysis was done:

Chicken Survival Rate = $\left(\sqrt{Y_{ij}}\right)$

Y_{ij} = survival rate of a farmer's chicks, growers, adult chickens or all chickens

The Generalized Linear Model was then used to compare the arcsine transformed percentage survival rates between communities, between farmers' genders and between treatments at a 5% level of significance after fitting observed survival rates to a model and using the Student Newman Keuls test to separate the means. Interactions between the community and the gender of the farmer as well as the treatment and gender of the farmer were explored. The Statistical Computing used was SAS 9.4.

The statistical model was explained as follows:

$$Y_{ijkl}=\mu + C_i + S_j + T_k + e_{ijkl}$$

Where:

Y_{ijkl} = the l^{th} survival rate of the k^{th} treatment of the j^{th} farmer in the i^{th} community

μ = overall mean

C_i = random effect of the i^{th} project community

S_j = fixed effect of the j^{th} gender of farmer

T_k = fixed effect of the k^{th} treatment

e_{ijkl} = random error

Results sharing

The results of the experiment were shared with cross-sections of the project community members. Using a checklist, feedback was obtained from the farmers on the results.

RESULTS AND DISCUSSION

Physicochemical and phytochemical properties of the plants and the decoction

In a related study, Sakyiamah (unpublished) found that aqueous extracts of the plants that the innovator used for the innovation had a pH of 5.64, a specific gravity of 1.0036 and a Total Solids Residue of 5.64. The phytochemical constituents of the preparation were also found to be flavonoids, triterpenes, phenolic compounds, polyuronides, saponins and reducing sugars which are known for their antiviral, antimicrobial, antiprotozoal, antiplasmodial, antiulcerogenic, anti-cariogenic, hepatoprotective, cardioprotective, anti-apoptosis, antiatherosclerosis, anti-aging, detoxification, anti-inflammatory, antioxidative, anticancer, analgesic, cell membrane permeabilising and immunomodulatory properties.

The treatment may, therefore, provide many health-giving benefits to the chickens including antiviral properties that may subdue Newcastle disease. The pH of 5.64 was within the acceptable range of 4.0 – 7.5 for fruits, vegetables, grasses, flowers, trees, shrubs and annuals (Vaikosen and Alade, 2011). Therefore, the extract could be used as an ethnoveterinary medicine. Total solid residue (TSR) represents all the phytochemicals extracted from the plant material. It also helps in quantifying the amount of plant extract administered. The TSR value of 5.64 would guide the innovator in quantifying the amount of extract that can be administered to animals, giving an idea of the dosage. The phytochemical composition and physicochemical properties, for example, the specific gravity of 1.0036, present useful information on the best preparation method for controlling NCD. In a recent study in the Ogun State of Nigeria, NCD was the most widespread disease of chickens and respondents used *Lagenaria breviflora* R. (spotted pumpkin), *Nicotania tabacum* (tobacco) and *Capsicum frutescens* (chilly pepper) as their ethnoveterinary medicine for its control (Ekunseitan et al., 2016). The plants that were used for the treatment of NCD in a cross-section of African countries did not include those that the innovator used but were rather *Combretum micrantum*, *Butyrospermum parkii*, *Ficus sp*., *Mangifera indica*, *Langenaria vulgaris*, *Lannea acida*, *Parkia filicoidea*, *Euphorbia ingens*, *Cassia sieberiana*, *Euphorbia candelabrum*, *Eucalyptus sp*., *Mucuna sp*, *Iboza multiflora* and *Capsicum annum* (Nwude and Ibrahim, 1980; Guěye, 1999; Kaoma and Chiteta, 2001; Yasin et al., 2019). Whereas in Ghana, the barks of trees were used, in Nigeria, they used the leaves and fruits of herbaceous plants which were less likely to kill the plants that were being exploited. Bodeker et al. (2005) reported that roots, whole plants, bark, stem, rhizomes and wood harvesting were destructive, while fruits, seeds, leaves and flower harvesting were non-destructive methods in ethnoveterinary medicine usage.

Project communities and categorisation of experimental farmers

The communities enrolled in the project were Daashei, Jangyili, Daboashie and Dakpemyili (Table 1). While Daashei and Jangyili were the treatment communities, Daboashie and Dakpemyili were the control communities. Forty farmers were on treatment versus 43 on control. Twenty-one male and 19 female farmers participated in the treatment whereas 26 male and 17 female farmers were placed on the control. The experimental farmers were in different age categories. The farmers who participated in the treatment were below 31 years (21), 31 to 40 years (9), 41 to 50 years (7) and 3 were above 50 years while the control farmers were 8 (below 31 years), 13 (31 to 40 years), 11 (41 to 50 years) and 11 (above 50 years). There appeared to be more youth (up to 35 years) in the treatment group compared with the control group.

Outcome variables for chicks

A total of three thousand, eight hundred and fifty -four (3,854) chickens belonging to 83 male and female farmers were used in the experiment. Of this total number, 41% (1,563) were chicks, 24% (913) were growers and 36% (1,378) were adults. The initial number of chicks was found to

Table 1: Project communities and the categorisation of the experimental farmers

Variable	Category	Treatment (%)	Control (%)	Total (%)	Chi-Square Test		
					Chi-Square Value	DF	p-value
Community	Daashei	20 (50)		20 (24.1)	0.0	3	1.000
	Jang-Yili	20 (50)		20 (24.1)			
	Daboashei		23 (53.5)	23 (27.7)			
	Dakpemyili		20 (46.5)	20 (24.1)			
Gender	Male	21 (52.5)	26 (60.5)	47 (56.6)	0.26	1	0.610
	Female	19 (47.5)	17 (39.5)	36 (43.4)			
Age	20 - 30	21 (52.5)	8 (18.6)	29 (34.9)	11.92	3	0.007
	31 - 40	9 (22.5)	13 (30.2)	22 (26.5)			
	41 - 50	7 (17.5)	11 (25.6)	18 (21.7)			
	> 50	3 (7.5)	11 (25.6)	14 (16.9)			
Total Number of Farmers		**40 (48.2)**	**43 (51.8)**	83 (100)			

*DF – *degree of fredoom*

be highest at Daashei, a treatment community and lowest at Daboashei, which was a control community ($p<0.05$) (Table 2). It was therefore realised that treatment communities had more chicks than the control communities ($p<0.05$) at the start of the experiment. There were more sick chicks reported at Jangyili than in the other communities however the differences were not statistically significant. However, for dead chicks, the differences were statistically significant as 97% of the chicks at Daboashie died compared with the 8% at Daashei. The treatment communities recorded a lower mortality rate (17%) compared with the control communities (87%) ($p<0.05$). Offtake of chicks was not common and the differences observed were not statistically significant. While few additions in the form of new hatches were observed in the control communities, significantly more hatches were observed at Jangyili, a treatment community. The additions were 74% for treatment versus 20% for control ($p<0.05$). A significant difference was also observed in the final numbers of chicks per farmer on treatment (13.19) compared with the control (8.71) ($p<0.05$) (Table 2).

The treatment was probably responsible for the vast difference in the mortality rates of the chicks, with Daboashei, a control community recording a 97% mortality rate compared with an 8% mortality rate at Daashei, a treatment community. According to Yasin et al (2019), village poultry farmers claimed that ethnoveterinary medicines used as preventive or curative treatments were effective. Chicks may be particularly more vulnerable to infections and stress (Botchway et al., 2022), therefore, the treatment possibly reduced the vulnerability of the chicks in the treatment communities. Rather than attacking the NCD virus, the treatment might have acted against protozoan and helminth parasites, and in the process reduced the disease burden of the chicks as well as boosted their immune system (Kubkomawa et al., 2020), but this needs to be ascertained. As the Dakpemyili community had a higher number of adult chickens, it was expected that they would have more chicks hatched during the experimental period. However, more chicks were hatched in the treatment communities than in the control communities

Table 2: The outcome variables analysed in the experiment

Variable	Community				Treatment/Control		Overall
	Daashei	Daboashei	Dakpemyili	Jang-Yili	Treatment	Control	
Initial Number of Chicks	14.87^c	7.61^a	11.46^b	10.44^b	12.58^a	9.41^b	10.96
Sick Chicks	0.04	0.08	0.08	0.17	0.11	0.08	0.09
Dead Chicks	0.08^a	0.97^b	0.75^{ab}	0.26^{ab}	0.17^a	0.87^b	0.53
Offtake Chicks	0.00	0.03	0.00	0.00	0.00	0.02	0.01
Addition Chicks	0.68^{ab}	0.21^a	0.18^a	0.81^b	0.74^a	0.20^b	0.47
Final number Chicks	15.60	6.81	10.89	10.95	13.19^a	8.71^b	10.91
Initial Number of Growers	8.42^b	5.82^a	7.47^b	4.42^a	6.35	6.59	6.47
Sick Growers	0.06	0.05	0.10	0.08	0.07	0.07	0.07
Dead Growers	0.13^a	0.74^a	0.59^a	0.12^a	0.12^a	0.67^b	0.40
Offtake Growers	0.04^a	0.11^{ab}	0.21^b	0.04^a	0.04^a	0.16^b	0.10
Addition Growers	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Final Number Growers	8.19^c	4.93^a	6.67^b	4.25^a	6.15	5.74	5.94
Initial Number of Adults	9.40^a	5.40^a	15.56^b	8.75^a	9.06	10.14	9.61
Sick Adults	0.02	0.05	0.04	0.04	0.03	0.04	0.04
Dead Adults	0.06^a	0.47^b	0.19^{ab}	0.02^a	0.04^a	0.34^b	0.19
Offtake Adults	0.01^a	0.07^{ab}	0.14^b	0.02^a	0.02^a	0.10^b	0.06
Addition Adults	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Final Number Adults	9.35^b	4.88^a	15.24^c	8.72^{ab}	9.02	9.70	9.37

Means on the same row with different superscripted letters (abcd) are significantly different ($p<0.05$).

suggesting that the physiological functions of the adult chickens in the control communities might have been compromised. Amoia et al (2021) reported that a marked decrease in egg production was one of the first signs of NCD. The treatment which was, therefore, given to the treatment group might have instilled good health for the chickens to perform their normal functions which included adequate feed intake (Botchway et al., 2022), and successful brooding and hatching of chicks.

Outcome variables for growers

The initial number of growers was more in the Daashei and Dakpemyili communities ($p<0.05$). Between treatment and control, the initial number of growers was however similar. There were no differences in the number of sick growers between treatment and control, however, 12% of the growers on treatment died compared with 67% on control ($p<0.05$). Offtake tended to be higher in Daboashei and Dakpemyili communities, therefore, offtake was significantly higher in the control group compared with the treatment group ($p<0.05$) (Table 2). There were no significant additions made to the growers. The final number of growers was higher at Daashei compared with Daboashei and Jangyili ($p<0.05$). The treatment might have also been responsible for the lower mortality rate of 12% observed in the grower treatment group compared with the 67% mortality rate observed in the grower control group. Because the farmers in the control group experienced higher mortality, they increased the disposal of their growers (Table 2) because some of the growers might have been fairly big to be consumed or sold for cash. On the contrary, farmers in the treatment group did not feel compelled to dispose of their growers because most of them were healthy and not threatened by death.

Outcome variables for adult chickens

Even though the number of adult chickens at Dakpemyili was higher than recorded in the other three communities ($p<0.05$), the difference between the number of adult chickens on treatment and on control was not statistically significant. There were also no significant differences in the number of sick adult chickens in one group compared with another group (Table 2). More of the adult chickens on control died (34%) compared with those on treatment (4%) ($p<0.05$). There was more offtake of adult chickens in the control group (10%) compared with the treatment group (2%) ($p<0.05$). Dakpemyili in particular recorded a higher offtake probably because they experienced high morbidity rates. No significant additions were made to the number of adult chickens used for the experiment. The final numbers of adult chickens per farmer were similar for both the treatment and control groups even though the final number of adult chickens at Dakpemyili per farmer was higher than the figures recorded at Daashei and Daboashei. The pie matrix (Figure 1) revealed that most deaths probably occurred at the beginning of the experiment, especially in the control communities.

The mortality rates were lower in older chickens indicating that older chickens might be more resilient to Newcastle disease. According to Amoia et al (2021), certain pathotypes of Newcastle disease caused a higher mortality rate in younger birds when compared with older ones. Walugembe et al. (2020) added that the resistance of chickens to the lentogenic type of the NCD virus could be improved through selective breeding. Within the adult group, the treatment might have been effective because the mortality rate was 4% compared with 34% in the control group. Therefore, the treatment group consistently experienced a lower mortality rate which might be attributed to the effect of the treatment. Another positive effect that decoctions were known to have was a reduction of the adverse impact of the velogenic Newcastle disease virus on the growth rate of chickens (Botchway et al., 2022). A higher offtake was observed in the control group because the experimental farmers probably felt compelled to dispose of their chickens which they probably thought might die of the disease.

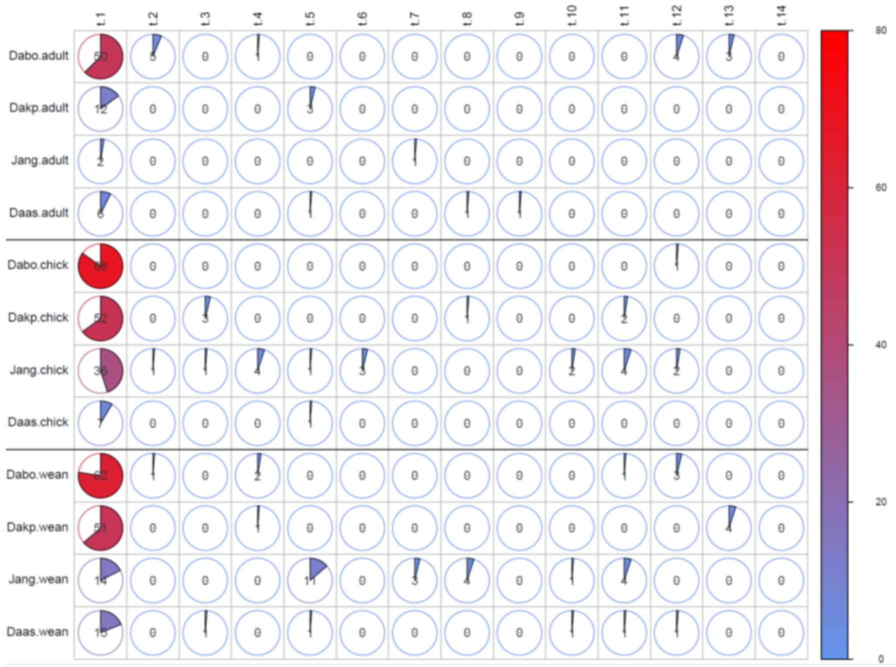

Figure 1: Fractional mortalities of the chickens during the experimental period

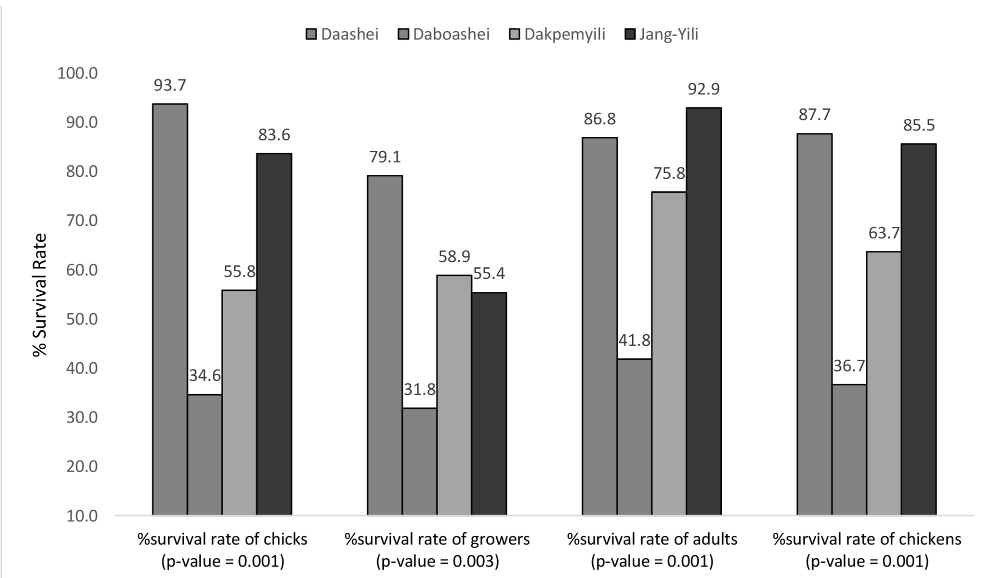

Figure 2: Survival Analysis by Community
Note: Considering a One-Way ANOVA, variables with a p-value less than 0.05 are significantly different between sample communities

Chickens' survival analysis by community

Figure 2 shows the survival rates of the experimental chickens in the project communities. There were significant differences in the survival rates of the chicks, growers and adult chickens ($p<0.05$). Generally higher survival rates were recorded in the treatment communities. Daboashei recorded lower survival rates than were determined in the other communities.

Guěye (1999) mentioned that the few experiments conducted on ethnoveterinary medicines tended to validate them as effective. Kaoma and Chiteta (2001) in an experiment using local chickens observed a 38.4% reduction in the mortality rate when they were treated with *Euphorbia ingens* during an outbreak of NCD.

Chickens' survival analysis by farmer's gender

In Figure 3, it is clear that the survival rates were similar for both men and women experimental farmers. The figure however gives a hint that the survival rates of the growers and adult chickens were looking a bit better for male farmers than for female farmers. Men were generally better resourced than women (Ekunseitan et al., 2016) and therefore might have provided better care for their chickens compared with the care that the women might have been capable of giving. Oladeji et al. (2022) observed that women chicken rearers in Nigeria used ethnoveterinary medicine more than men because the women did not have money to be buying conventional antimicrobials for their chickens. Therefore, chickens belonging to these women probably had fewer healthcare options compared with those of the men.

Chickens' survival analysis by farmer's age category

Farmers aged 41 to 50 recorded higher survival rates for their chicks and growers than farmers aged above 50 years. Farmers aged up to 30 also recorded better survival rates than farmers who were above 50 years old (Figure 4). While 50% of the farmers who were enrolled in the treatment communities were in their twenties, about 26% of those enrolled in the control communities were above 50 years old. The effect of the treatment has caused the young farmers to have more of their chickens surviving as compared with the older farmers.

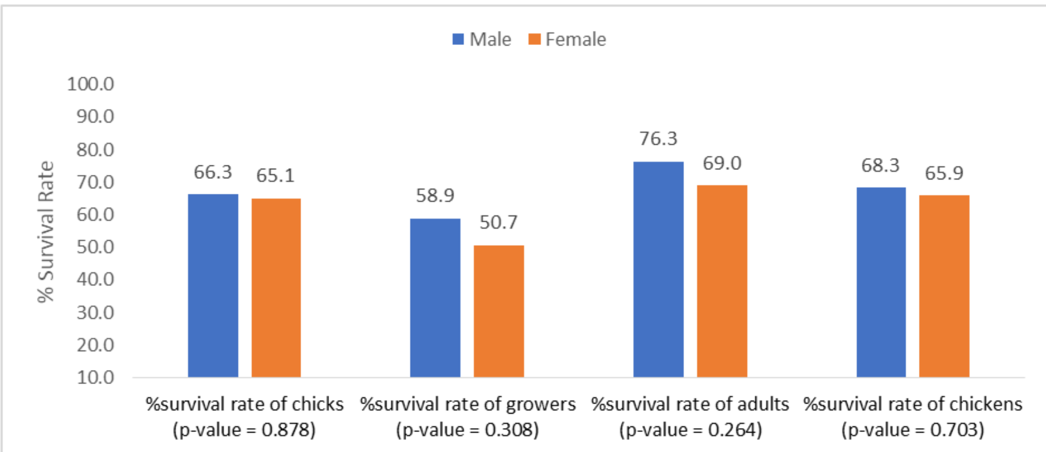

Figure 3: Survival Analysis by Farmer's Gender

Note: Considering a One-Way ANOVA, variables with a p-value less than 0.05 are significantly different within sample genders

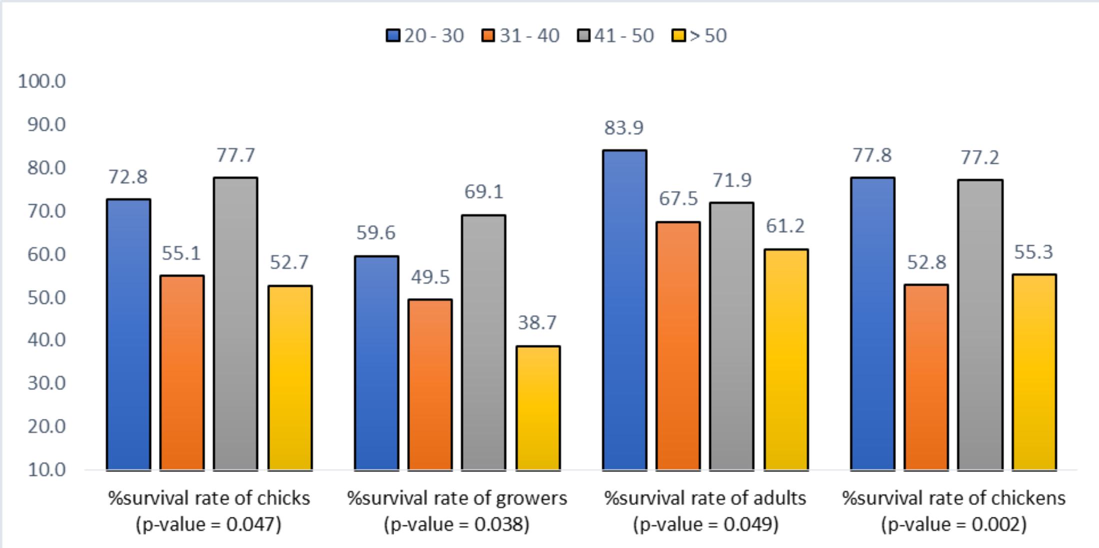

Figure 4: Survival Analysis by Farmer's Age Category
Note: Considering a One-Way ANOVA, variables with a p-value less than 0.05 are significantly different within sample age categories

CONCLUSION AND RECOMMENDATIONS

The chickens in the treatment communities were probably relatively healthier because they hatched more chicks during the data collection period. In the control communities, there was more offtake as a result of probably a higher incidence of NCD. Daashei and Jang-Yili, which were the two treatment communities, recorded the lowest incidence of deaths in chicks, growers and adult birds. At the end of the experiment, farmers whose birds were on treatment had more chickens to dispose of. There is a need to clarify if the decoction subdues the NCD virus or if it helps to keep chickens alive during the NCD season.

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