EFFECT OF FEEDING PROPOLIS ON EGG PRODUCTION, EGG SIZE AND EGG QUALITY IN COMMERCIAL LAYERS

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DEDICATION

This work is dedicated to my brothers; Michael and Martin and to my sisters; Matilda and Mirriam.

DECLARATION

I hereby declare that the work done in this project has been done by me and all other sources of information acknowledged.

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ABSTRACT

In this study, the effect of feeding Propolis on egg production, egg size and egg quality were determined. The parameters of egg quality examined were weight (egg, yolk, albumin, shell); pH (yolk, albumin); and shell thickness using a micrometer screw gauge. A total of 180, 75-week old Bovans Brown layers were divided into four groups of 45 hens each. The hens were randomly divided into four treatment groups namely T0, T1, T2 and T3, in which Propolis was administered at 0ml, 0.5ml, 1ml, and 1.5ml per litre of drinking water respectively in a completely randomised design (CRD). The separation of the hens in the pen was done using chicken mesh wire. The study was conducted for a period of 5 weeks. One way Analysis of Variance (ANOVA) was done using SPSS version 16 to determine the effects of the different treatments. Separation of means was done using Duncan's multiple range test. In the analysis of egg production and egg size, the results showed significant differences among the treatments. The hens given 1ml of Propolis per litre of water laid more eggs, 39(average of 45 hens over a period of 5 weeks) compared to the other treatments. Heavier eggs were laid by hens given 0.5 ml Propolis per litre of water, 6 kg (average of 45 hens over a period of 5 weeks). Egg quality results reveal that Propolis increased shell thickness ($P<0.05$). In conclusion, Propolis increased egg production, egg size and shell thickness. It is recommended that further studies be done to determine the quality of Propolis in terms of chemical properties, obtained from different tree species in Zambia and determine the best source of the locally produced Propolis.

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ACRONYMS

T0	CONTROL
T1	TREATMENT 1
T2	TREATMENT 2
T3	TREATMENT 3
PAZ	POULTRY ASSOCIATION OF ZAMBIA

CHAPTER ONE

INTRODUCTION

1.1 COMMERCIAL EGG PRODUCTION IN ZAMBIA

Commercial laying hens are economic agriculture field production units in which the objective is to maximize field performance (Galal et al., 2008). In Zambia, poultry production was estimated at 31.5 million broilers and the annual pullet production was 1.44 million or average of 30,000 pullets per week, at the end of 2011. About 65% of this production is in the hands of smallholder farmers while the remaining 35% by commercial farmers (PAZ 2011).

1.2 EFFORTS TO INCREASE EGG PRODUCTION USING PROPOLIS

Propolis is the generic name for the resinous product of complex composition collected by honey bees from buds and exudates of various plants. More than 300 constituents have been identified so far, among which phenolic compounds, including flavonoids, are major components. Propolis has attracted researchers' interest in the last decades because of several biological and pharmacological properties, such as immunomodulatory, antitumor, antimicrobial, antitrypanosomal activities, antioxidant and angiogenesis. (Shijin et al., 2011).

Propolis cannot be used as a raw material; it must be purified by extraction with solvents. This process removes the inert material and preserves the polyphenolic fractions. Extraction with ethanol is particularly suitable to obtain dewaxed Propolis extracts rich in polyphenolic components and this is the most commonly used solvent. (Shijin et al.2011). Some unconventional feed additives such as *aloe vera* leaf extract (Kitalya, 1998) and propolis ether extract (Buhr tel et al., 1983) have been tested in improving egg production with varying results. Propolis in particular, is of interest in Zambia due to its availability among bee keepers (Kitaly a, 1998). Bonomi et al. (1976) observed that using propolis as a supplement in the diet increased egg weight, egg production and feed utilization. Sebastian (2010) reported that adding propolis solution to the diet of layers increased egg production by 16%. It has also been reported that the quality and activity of Propolis is dependent on geographical location where it was collected, time and plant source (Markham et al., 1996). Although numerous reports concerning the biological activities of Propolis collected in certain countries have been documented, little is known about the

effects of locally produced Propolis on the performance of layers. This study is aimed at investigating the effect of locally produced Propolis on the performance of layers by determining egg weights and egg production when Propolis is added to drinking water.

1.3 EGG QUALITY

Egg shell quality and internal quality are of major importance to the egg industry worldwide. Egg shell quality may be measured as shell colour, shell breaking strength, shell deformation (destructive or non destructive), shell weight, percentage shell, shell thickness, and shell ultrastructure. Egg internal quality is measured as yolk colour, the integrity of the perivitelline membrane, and albumen quality. The complexity of the process of egg shell formation means that imperfections can arise in a number of places in the oviduct of the hen. Egg shell quality may be affected by the strain and age of hen, induced moult, nutritional factors such as calcium, phosphorus, vitamins, water quality, non-starch polysaccharides, enzymes, contamination of feed, general stress and heat stress, disease, production system, or addition of proprietary products to the diets. Egg internal quality may be affected by storage; hen strain and age; induced moult, nutrition, and disease. An understanding of the range of factors that affect egg shell quality and egg internal quality is essential for the production of eggs of high quality (Roberts, 2004).

1.4 JUSTIFICATION

Propolis used as an unconventional feed additive has been reported to possess antibacterial and antifungal properties including promoting immunity and tissue generation (Ohkawa et al. 1979). While Propolis has been used in poultry in attempts to increase egg production and egg size in other parts of the world, no significant work has been done in Zambia. Therefore, the effects of locally produced Propolis on eggs are not known.

1.5 OBJECTIVES

The overall objective of this study was to determine the effect of feeding Propolis on egg production, egg size and egg quality of commercial layers.

A previous study at the University of Zambia (Mpandamwike, 2012) established that significant differences among treatments were not observed because the trial was carried out in a short period of time. It was therefore, important to establish whether the differences were not observed because of the duration of the experiment or not.

The specific objectives were:

1. To determine the effects of feeding Propolis on egg production
2. To determine the effects of feeding Propolis on egg size
3. To determine the effect of feeding Propolis on egg quality

1.6 HYPOTHESIS

H_o: There is no increase in egg production when Propolis is added to drinking water.

H_a: There is an increase in egg production when Propolis is added to drinking water.

H_o: There is no increase in egg size when Propolis is added to drinking water.

H_a: There is an increase in egg size when Propolis is added to drinking water.

CHAPTER TWO

LITERATURE REVIEW

2.1 PROPOLIS

Propolis (bee glue) is a complex resinous hive product that is dark yellow to brown in colour. It is a mixture of wax, sugars and plant exudates, collected by bees from the buds, leaves, bark and other parts of the tree (Banskota et al., 2001). Propolis is used by worker bees to line the inside of nest cavities, to seal small cracks in the hive and to reduce the size of hive entrances (Krell, 1996).

The main components of Propolis are flavonoids, phenolic acid, and terpenoid contents. Other components include vitamins A and B, trace elements of iron, calcium, silicon, magnesium and zinc. It is also known to have a variety of amino acids, enzymes, polysaccharides, aldehydes and ketones (Kimoto et al., 1999; Prytzyk et al., 2003). Middleton et al. (1993) was of the opinion that the principle components responsible for biological activities of propolis are flavonoids. Flavonoids are polyphenolic compounds diverse in chemical structure and characteristics that occur naturally in fruits, vegetables, nuts and flowers. Flavonoids have been reported to exhibit a wide range of biological effects, including anti-bacterial, anti-viral (Hanasaki et al., 1994), anti-inflammatory, anti-allergic (Middleton et al 1993) and vasodilatory actions (Duarte et al., 1993). The flavonoids also show antioxidant characteristics to ascorbate oxidant in cell membranes (Havsteen, 2002). The oxidative effects of Propolis can relieve the adverse effects of lipids peroxidation and radical free formation (Ohkawa et al., 1979; Tatli et al., 2009).

Another compound in the structure of Propolis, caffeic acid phenethyl ester (CAPE), has been found to block the production of reactive oxygen (Hosnuter et al., 1979). Generally, Propolis is an excellent natural antibiotic, immune system booster and has important pharmacological properties such as antioxidative, antitumor, antimicrobial, antihepatotoxic and anti-inflammatory properties (Bratter et al., 1979; Velikova et al., 2000; Banskota et al, 2001).

The use of Propolis as a feed additive for poultry and domestic animals promotes their growth and at the same time can increase resistance to disease (Galal et al., 2008). According to Tatli et al (2009), the addition of 5% Propolis solution to the diet of spring chicken for 75 days resulted in 12% weight gain compared with standard fed chicken. In a

similar experiment, additi n of 5 % Propolis solution to the diet of layers increased egg production rate by 16%, owered feed consumption by 14% and reduced mortality by 22%. Bonomi et al. (197( ) conducted a study on the use of Propolis in Hubbard Golden hens with average weight f 1.85 kg. The birds were given Propolis at different treatment levels (0, 10, 20, 30 mg/k; diet). Propolis in the diet significantly increased body weight by 6%.

2.2 EGG QUALITY

Measurement of egg shell uality

Egg shell quality may be measured in a number of ways. Some of these methods necessitate the destruction of the egg. Direct methods include measures of shell breaking strength such as impact racture force, puncture force or quasi-static compression. Indirect means include spe ific gravity, non-destructive deformation, shell thickness and shell weight.

In commercial operations, eggs are either candled using light to detect cracks and other defects or they pass throu h an electronic crack detector for detection of cracks. The specific gravity of the who e egg may be measured by immersing eggs in salt solutions of different specific gravity to see at what concentration of solution they float. Alternatively, special equipment can be sed based on Archimedes principle. However, a number of authors have raised questi ns as to the validity of the use of egg specific gravity as a measure of egg shell qual y. At best, it is an indirect indicator of the amount of shell present in relation to the size of the egg. Shell colour may be monitored by visual comparison with a series o graded standards or it may be measured by shell reflectivity, which is detection of the p oportion of incident light that is reflected from the surface of the egg, under controlled c nditions. Egg weight is easily measured by a suitable balance.

The measurement of shell reaking strength and shell deformation (either destructive or non-destructive) requires t e use of special equipment. Shell breaking strength is most commonly measured by q asi-static compression where the egg is compressed under controlled conditions until the shell cracks or breaks. The minimum force required to cause failure of the shell is then recorded. Studies have shown a strong negative correlation between shell b eaking strength measured by quasi-static compression and the percentage of cracks .Shell deformation may be non-destructive where the deflection of

the shell under a given force is measured, or it may be destructive and measured as the distance the shell is compressed before it fails The amount and thickness of the egg shell have been found to be related to egg shell strength. Shell weight may be measured by breaking open an egg, carefully rinsing the pieces of shell, drying them and then measuring shell weight. The shell weight can then be calculated as a proportion of egg weight to give percentage shell. Shell thickness may be measured by a suitable gauge and is usually measured on three pieces of shell taken from around the equator of the egg. A gauge based on a Mitutoyo Model 2109-10 Dial Comparator Gauge, mounted on a frame, is used to measure shell thickness.

The strength of an egg shell is determined not just by the amount of shell that is present, but also by the quality of construction of the shell. Studies of the quality of construction are conducted by examining the ultrastructure of the egg shell under the scanning electron microscope. In circumstances where shell weight, percentage shell and shell thickness are good, but shell breaking strength is relatively poor, the explanation probably lies with the shell ultrastructure, or how well the shell has been constructed (Roberts,2004).

The effect of Propolis on egg quality

Although the shell thickness is the main factor, it is not the only factor that determines strength. Propolis dietary supplementations have succeeded in significantly improving the egg shell traits in comparison with the heat stress control group. The positive effect of Propolis on the egg shell quality would be probably linked to increases in calcium digestibility and absorption due to acid derivates such as benzoic, 4-hydroxy-benzoic acids found in Propolis (Seven et al., 2011).

CHAPTER THREE

MATERIALS AND METHODS

3.1 LOCATION OF S1 UDY

The study was conduct d at St. Augustine's Mpima Major Seminary farms in Kabwe, Central Province. The fa m is about 5 km off the Kabwe - Kapiri Mposhi main road from Chindwin Barracks.

3.2 SOURCES OF MA 'ERIALS

The Propolis was obta ned from bee farms in Kitwe and Kabompo districts. The commercial feed used w s bought from LKM Milling in Kabwe district. The commercial layers used were bought rom Yielding Tree.

3.3 EXPERIMENTAL)ESIGN

The study was conducte in a Completely Randomised Design (CRD), in which 180, 75-week old Bovans Brown layers were subjected to four treatments 0ml (T0), 0.5ml (T1), 1ml (T2) and 1.5ml (T3) mls Propolis per litre of water. A total of 45 hens were allocated to each treatment (Table refers).

Table1. Shows the nun ber of hens per treatment and the amounts of Propolis per treatment.

Treatments		Number of hens			Total
		Replicate 1	Replicate 2	Replicate 3	
T0	0 ml Propolis/litr of drinking water	15	15	15	45
T1	0.5ml Propolis/lit e of drinking water	15	15	15	45
T2	1ml Propolis/litre of drinking water	15	15	15	45
T3	1.5ml Propolis/lit e of drinking water	15	15	15	45
	TOTAL				**180**

3.3.1 Preparation of Poultry House

Before the start of the experiment, the poultry house was cleaned, cobwebs removed and disinfected. The pens were divided using chicken mesh wire ($1x2m^2$). The hens were reared in a deep litter system with maize bran as litter.

3.3.2 Feed and Water

Commercial layers feed bought from LKM Milling in Kabwe district was given to the birds *ad libitum*. The birds were manually fed using ordinary plastic tubular feeders (10 liters). Water (from the borehole) was given *ad libitum*. However, fresh water was given every morning, and fresh feed was given at 8:00 hrs and at 14:00 hrs.

3.3.3 Propolis Extraction Process

900g Propolis was cut into very small pieces using a knife; it was cleaned to remove any dirt and wood particles. The pieces were mixed with 2.5 Litres of 96% ethanol and kept in an air tight container in the dark at room temperature for two weeks to obtain the extract. The mixture was shaken twice a day. After two weeks, the mixture was filtered using a 2mm kitchen sieve to obtain the extract. The extraction of Propolis is shown in Figure 1.

Figure1. Showing the extraction of Propolis on Day 1.

3.4 LABORATORY M :THODOLOGY

The laboratory analysis vas done at the University of Zambia's Department of Animal Science Laboratory. 5 (ggs were randomly sampled from each treatment to measure weight, pH and shell thic :ness.

3.4.1 Measurement of Weight

The weight of eggs, she l, yolk and albumin was determined using an electronic scale. The shells were separate l from the egg contents, washed and dried, then weighed. The albumin was separated fr :m the yolk and their weights taken.

3.4.2 Shell Percentage

Shell percentage was det rmined by calculating as follows:

Shell percentage= Shell weight/egg weight x 100

3.4.3 Measurement of p I

The yolk and albumin w :re decanted into separate small plastic containers and the pH readings taken using a pH meter.

3.4.4 Shell thickness

The dry shells were cut ir half and their thickness measured around the equator of the egg using a micrometer screw gauge. The readings were determined as follows: main reading x 0.01+ reading on the ve ier scale (mm).

3.5 STATISTICAL AN \LYSIS

Analysis of Variance (AN OVA) was done using SPSS version 16. The Duncan's multiple range test was used to sep rate statistically different means.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 EGG PRODUCTIC N

Significant differences vere observed in egg production. The hens that were given T2 *(1ml Propolis per liter* o. water*) had the highest number of eggs produced, 39(average of* 45 hens over a period (f 5 weeks) while the hens in the control group had the least number, 21(average of 4: hens over a period of 5 weeks) (Table 2 refers).

Table 2: Showing the m :an values of egg production and egg size (g), (Averages of 45 Hens for 5 wks).

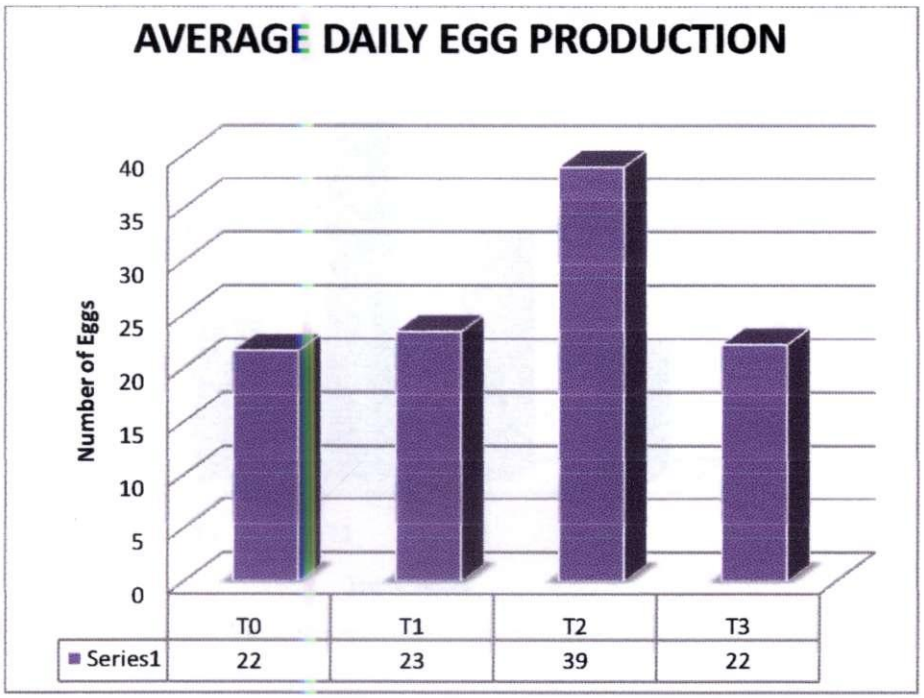
Treatments	E| g production	Egg size(g)
T0	21	63[a]	66.62[a]
T1	23	40[a]	68.02[b]
T2	38	83[b]	67.06[ab]
T3	22	20[a]	66.12[a]
SEM	1.:	49	0.506

Note: Values with c fferent superscripts are significantly different (P< 0.05).

T0- 0ml Propolis/litre of · rinking water, T1-0.5 ml Propolis/litre of drinking water, T2-1ml Propolis/litre of drinl ing water, T3-1.5 ml Propolis/ litre of drinking water.

There were no significant differences observed in number of eggs produced in the control group, T0 (0ml Propolis] er litre of water), T1 (0.5 ml per liter of water), and T3 (1.5 ml per liter of water) thoug they were all significantly different from treatment T2 (1ml Propolis per liter of wat(r). The significant difference in the number of eggs produced could be due to the effe ts of flavonoids that are found in Propolis and are known to neutralize free radicals w ich damage body tissues, hence helping in tissue regeneration. Okhawa et al. (1979) con luded that the oxidative effects of Propolis can relieve adverse effects of lipids peroxidat on and free radical formation. Figure 2 shows average daily egg production.

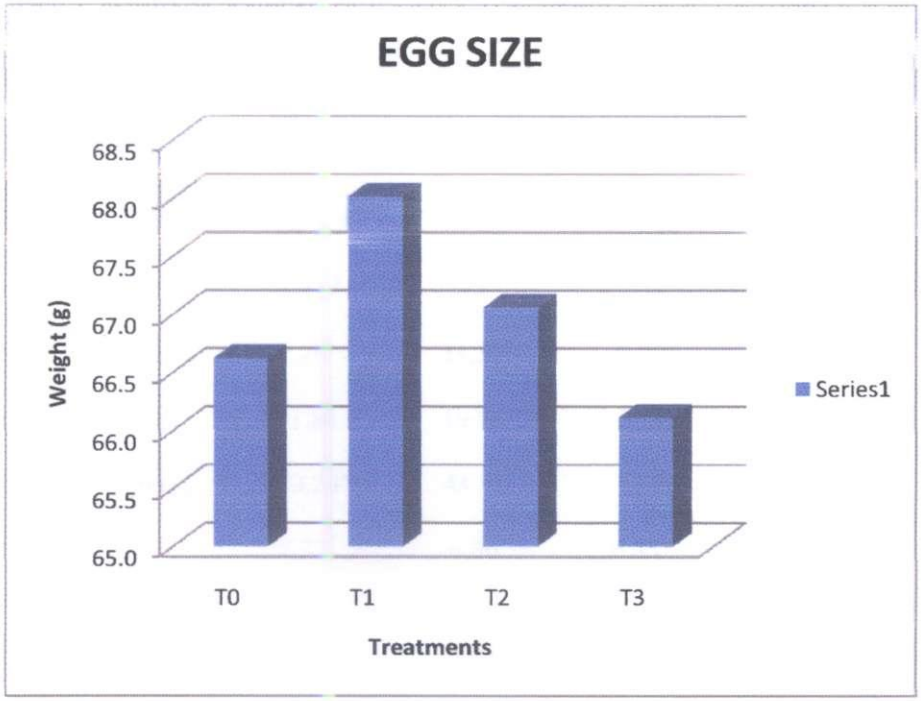
Figure 2: Showing the average daily egg production (45 hens over a period of 5 weeks), T0 (Control); T1 (0.5ml Propolis per litre of water); T2 (1ml Propolis per litre of water); T3 (1.5ml Propolis per litre of water).



4.2 EGG SIZE

Significant differences were observed in egg size (g). The hens that were given T1 (0.5 ml Propolis per liter of water) produced the heaviest eggs, 68g (average of 45 hens for 5 weeks). The hens that were given T3 (1.5 ml Propolis per litre of water) produced the least heavy eggs, 66.11g (average of 45 hens for 5 weeks). There were no significant differences in egg size among hens given T0 (0ml Propolis per litre of water), T2 (1ml Propolis per litre of water) and T3 (1.5 ml Propolis per liter of water). The eggs produced by hens given T1 (0.5 ml Propolis per litre of water) were also not significantly different from those produced by hens given T2 (1ml Propolis per litre of water). T2 (1ml Propolis) had lighter eggs produced as compared to T1(0.5 ml Propolis), this could be because an increase in the number of eggs produced per hen requires less time for the eggs to be formed and laid, hence smaller eggs are formed. This is because the longer it takes for eggs to be formed, the heavier the eggs that are produced. In addition, more time is allowed nutrients for like water and proteins to be absorbed by the egg. Figure 2 shows the average egg weight (g).

Figure 3. Showing the average egg weight (g) for 45 hens over a period of 5 weeks.



4.3 EGG QUALITY

4.3.1 Shell thickness

Significant differences were observed in shell thickness among the treatment. T1 (0.5 ml Propolis) had the thickest shells while T0 (0ml Propolis) had the thinnest shells. T0 (0ml Propolis) was significantly different from the other treatments. T1 (0.5 ml Propolis) was also significantly different from the treatments but T2 (1 ml Propolis) and T3 (1.5 ml Propolis) were not significantly different. These results are similar to those obtained by (Seven et al., 2011) in which Turkish Propolis was used as an alternative to antibiotic on growth and laying performances, nutrient digestibility and egg quality, the results obtained in the study show that Propolis had a positive effect on shell quality and this would be probably linked to increases in calcium digestibility and absorption due to acid derivates such as benzoic, 4-hydroxy-benzoic acids found in Propolis.

4.3.2 Other parameters of egg quality

There were no significant differences observed in shell weight, shell percentage, yolk weight, albumin weight, yolk pH and albumin pH (Table 3 refers).

Table 3: Showing the mean values for parameters of egg quality (Averages of 5 eggs after 5 weeks of the study)

Parameter	Treatments				
	T0	T1	T2	T3	SEM
Egg weight	64.12[a]	67.02[ab]	73.44[ab]	64.32[a]	3.689
Shell weight(g)	6.3[a]	7.66[b]	7.28[ab]	7.16[a]	0.499
Shell percentage(%)	9.7[a]	11.52[b]	9.89[ab]	11.18[ab]	0.739
Yolk weight (g)	21.84	19.24	21.40	19.60	1.743
Albumin weight(g)	33.4[a]	43.52[b]	43.06[b]	39.78[ab]	4.107
Yolk pH	7.2[a]	6.96[a]	6.83[a]	6.73[b]	0.214
Albumin pH	7.8	8.53	8.25	8.93	0.502
Shell thickness (mm)	0.77[a]	0.89[c]	0.83[b]	0.81[b]	0.017

Note: Values with different superscripts are significantly different at ($P< 0.05$).

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

The results obtained show that locally produced Propolis has a significant positive effect on egg production and egg weight, although the highest egg production was recorded when Propolis was given at a dose of 1ml per litre of drinking water and more than that the egg production reduces. The heaviest eggs were produced when Propolis was given at 0.5 ml per litre of water. The results also show that Propolis has a significant positive effect on shell thickness but not on the other parameters of egg quality that were tested.

Studies have shown that the quality of Propolis depends on the location, time and plant source. Therefore, it is recommended studies be done to determine the quality of Propolis in terms of chemical properties obtained from different tree species in Zambia and determine the best source of the locally produced Propolis.

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APPENDIX 1

PROPOLIS TINCTURE CONCENTRATION PROCEDURE

1. To get the desired percent Propolis (30% tincture) in column 2, follow across to column 3 to find the amount of extract to evaporate.

Start extract	Desired extract	% volume to reduce
10	20	50
10	30	66.7
10	40	75
20	30	33.4
20	40	50
30	40	25

If you have 30% extract and want to have 40% you would have to let 25% of the alcohol evaporate. If you started with 1 cup, you would let it evaporate until you have 3/4cup remaining.

2. Let the container set with the cover off until the correct amount is evaporated off. You can hurry it along by warming it up. Be careful because alcohol is flammable.

CHART FOR EXTRACTION USING METRIC MEASUREMENTS

Tincture	100% Ethanol		Propolis
	Grams	Ml	Grams
10%	900	1146	100
20%	800	1019	200
30%	700	892	300

Tincture	70% Ethanol		Propolis
	Grams	Ml	Grams
10%	900	1073	100
20%	800	953	200
30%	700	834	300

APPENDIX 2

ANOVA TABLES

Table 4. Egg production

EGGPROD					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7133.829	3	2377.943	87.049	.000
Within Groups	3715.143	136	27.317		
Total	10848.971	139			

Table 5. Average Egg weight

ANOVA

EGGWEIGHT					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	68.438	3	22.813	5.097	.002
Within Groups	608.668	136	4.476		
Total	677.106	139			

Table 6. Egg quality

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
GWT	Between Group	266.461	3	88.820	2.610	.087
	Within Groups	544.456	16	34.029		
	Total	810.917	19			
IELLWT	*Between Group*	*4.789*	*3*	*1.596*	*2.560*	*.091*
	Within Groups	9.980	16	.624		
	Total	14.769	19			
LKWT	Between Groups	25.008	3	8.336	1.097	.379
	Within Groups	121.604	16	7.600		
	Total	146.612	19			
WT	Between Groups	330.678	3	110.226	2.613	.087
	Within Groups	674.860	16	42.179		
	Total	1005.538	19			
ELLPERCENTAGE	Between Groups	11.691	3	3.897	2.852	.070
	Within Groups	21.863	16	1.366		
	Total	33.554	19			
ELLTHCK	Between Groups	.039	3	.013	17.918	.000
	Within Groups	.012	16	.001		
	Total	.051	19			

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
YOLKPH	Between Groups	.264	3	.088	1.931	.266
	Within Groups	.182	4	.046		
	Total	.446	7			
ALBPH	Between Groups	1.288	3	.429	1.708	.302
	Within Groups	1.006	4	.252		
	Total	2.295	7			

MEAN SEPARATION I SING DUNCAN`S TEST

Table 7: Egg productior

	TRT	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	0	35	21.6286	
	3	35	22.2000	
	1	35	23.4000	
	2	35		38.8286
	Sig.		.184	1.000

Table 8: Egg Weight

	TRT	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	3	35	66.1154	
	0	35	66.6214	
	2	35	67.0603	67.0603
	1	35		68.0171

	Sig.	.079	.061

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 35.000.

Table 9: Egg Quality

EGGWT

	TRT	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	3	5	64.3200	
	0	5	64.7200	
	1	5	67.0200	67.0200
	2	5		73.4400
	Sig.		.499	.101

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table 10: SHELLWT

	TRT	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	0	5	6.3200	
	3	5	7.1600	7.1600
	2	5	7.2800	7.2800
	1	5		7.6600

	Sig.		.086	.357

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table 11: YOLKWT

	TRT	N	Subset for alpha = 0.05
			1
Duncan[a]	1	5	19.2400
	3	5	19.6000
	2	5	21.4000
	0	5	21.8400
	Sig.		.188

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table 12: ALBWT

	TRT	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	0	5	33.3400	
	3	5	39.7800	39.7800
	2	5		43.0600
	1	5		43.5200
	Sig.		.136	.401

Means for groups in homogen ous subsets are displayed.

a. Uses Harmonic Mean Samp e Size = 5.000.

Table 13: SHELLPERCE NTAGE

	TRT	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	0	5	9.7820	
	2	5	9.8940	9.8940
	3	5	11.1760	11.1760
	1	5		11.5160
	Sig.		.092	.053

Means for groups in homogen ous subsets are displayed.

a. Uses Harmonic Mean Samp e Size = 5.000.

Table 14: SHELLTHCK

	TRT	N	Subset for alpha = 0.05		
			1	2	3
Duncan[a]	0	5	.7660		
	3	5		.8140	
	2	5		.8320	
	1	5			.8900
	Sig.		1.000	.309	1.000

Means for groups in homogene ous subsets are displayed.

a. Uses Harmonic Mean Samp e Size = 5.000.

Table 15: YOLKPH

	TRT	N	Subset for alpha = 0.05
			1
Duncan[a]	3	2	6.7350
	2	2	6.8350
	1	**2**	6.9650
	0	**2**	7.2200
	Sig.		.090

Means for groups in homogene ous subsets are displayed.

a. Uses Harmonic Mean Sampl e Size = 2.000.

Table 16: ALBPH

	TRT	N	Subset for alpha = 0.05
			1
Duncan[a]	0	2	7.8300
	2	**2**	8.2450
	1	**2**	8.5250
	3	**2**	8.9300
	Sig.		.098

Means for groups in homogene ous subsets are displayed.

a. Uses Harmonic Mean Samp e Size = 2.000.