Study Report:

Effect of supplementation of MICRO – COMPLETE – a product from PROBYN INTERNATIONAL INC., USA on performance and gut health in layer chickens

Introduction

In layer poultry farming, pullet period is critical to prepare for laying and also during the laying period especially at peak, layers might be very sensitive to diseases. To reduce this risk, chickens were often supplied antibiotic in feed or drinking water for some certain times or even more. It is the big public health concern due to the problem of residues and antibiotic resistance. Probiotic and prebiotic are the well-known alternatives for antibiotic replacement of this purpose. However, many commercial products are available without knowing their clear efficacy. A new product in Vietnam market which is specific for chicken, **MICRO – COMPLETE** – a product from **PROBYN** company - containing digestive enzymes, lactic acid bacteria and *Saccharomyces cerevisiae*) is a potential solution to improve gut health and then performance in layer chicken from pullet to laying period. This study was carried out to evaluate the effect of the product.

Materials and Methods

Study design

The study was conducted from January 2019 to June 2019 at Anh-Dương farm, Ben Cat District, Binh Duong Province. This is a commercial large-scale layer farm. On the farm, 2 types of chicken were the target of the study: pullet from 8 to 14 weeks of age and laying hen from 25 to 31 weeks of age. These chickens were reared in difference houses of 21,000 chickens. For each type of chicken, there were 2 groups: control group and treatment group (MICRO – COMPLETE supplementation with the dose of 500g / ton of feed). Other factors such as husbandry management, vaccination program was followed to farm's schedule, and were the same for both two groups.

Data collection

During study, performance data would be collected from week-age 15 to 19 in pullets and 25-29 in layer. Data maybe collected daily or weekly with a number of chickens in the groups on the base of type of parameters. The parameters to be collected are described below

(i) **Production indicators** such as body weight, feed consumption in pullet, and egg production in layers. Because data were collected in a representative individual/ group/ house, the number of observations might be different.

(ii) **Mortality**: number of deaths per 1000 chicks could be calculated daily or aggregated into week

(iii) **Daily fecal scores** were performed. For each group, at least 50 fecal clumps were evaluated in the scale from 0-3 (0: small and compact dropping with white cap, no sign of wetness; 1: increase size, bulky, oily, moist; 2: watery, undigested feed, loss of firmes and sloughed off mucosa; 3: No consistency at all (no shape), watery, mucus, undigested feed and foamy)

(iv) **Intestinal microflora** was evaluated by counting the number of bacteria in a gram of feces (*Clostridium perfringens*, *Lactobacillus*, *E.coli*, and *Bacillus*). There were 2 points of time for sampling: before the study and after the supplement for 4 weeks. For each point of sampling, 5 chickens from each group were sent to the Vet hospital (Nong Lam University) for fecal sampling and autopsy. Fecal samples were sent to the microbiological lab of the hospital to count for those bacteria following the conventional method of plate count of the lab.

(v) **Length of villi and depth of crypt** in the duodenum: The chicken sent to the vet hospital were also performed autopsy and intestine were collected to send to the lab to make a special staining and measure the villus length and crypt depth to assess gut health of study chickens.

Data analysis

Data were managed in MS Excel 2013 then export to Stata 14 (StataCorp. 2015. College Station, TX: StataCorp LP) for statistical analysis. Feed consumption, body weight, villus lengths, and crypt depths between 2 groups in each type of chicken were compared using ANOVA. Egg production and mortality data seem to be the count number over a quantity, Poisson regression were used to assess the effect of treatment comparing to control group via coefficient values. These values can be transport to natural exponential forms to understand how many times of increase/ decrease of the treatment group to the control group in terms of the interested parameters. For fecal scores which are ordered data, the comparison between 2 groups would be performed by non-parametric Kruskal-Wallis test.

Results

- ***Growth indicators of pullets***

Although pullets were not considered much on the growth rate, their weight should be controlled very well, not too skinny ad not too fat, and high uniformity. Table 1 and Figure 1 show weekly body weights of pullets in the study respectively. The weights in treatment group seemed to vary lower than in the control group with **smaller value of SD** (standard deviation). There is no difference between 2 groups during the later weeks. Table 2 and Figure 2 show the feed consumption of the 2 groups. It can be seen that the treatment group can have more feed consumption, however, there is not significant difference. The number of data is small due to the pool data - individual bird or pens could not be achieved. From this point of finding, the supplement prepared a good start for pullets to go to the laying stage.

Table 1. Weekly weights (gram) of pullets in the study

Week age	Number of weighted birds	Control group		Treatment group		p value
		Mean	SD	Mean	SD	
15	80	943.3	128.2	980.8	109.2	0.0482
16	80	1085.3	105.9	1067.4	116.0	0.3102
17	80	1160.3	86.6	1128.4	105.4	0.0382
18	80	1179.5	109.8	1185.0	108.0	0.7504
19	80	1254.9	**130.1**	1247.8	**109.0**	0.7077

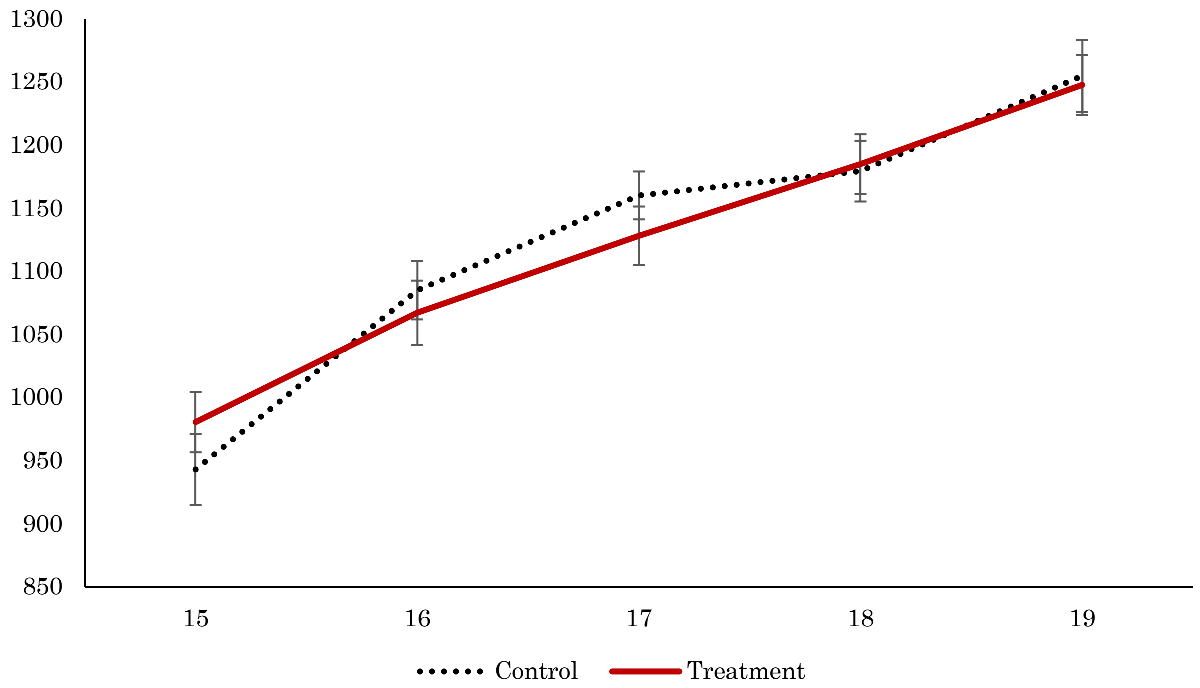

Figure 1. Weekly body weights (gram) with their 95% of confident interval of pullets in two groups

Table 2. Average feed consumption (gram/bird/day) of pullets by weeks in the study

Week age	Number of data	Control group		Treatment group		p value
		Mean	SD	Mean	SD	
15	12	62.0	6.1	58.4	2.8	0.0090
16	14	69.9	4.7	66.4	3.2	0.0120
17	14	65.4	5.0	62.0	5.8	0.0230
18	14	55.0	10.6	63.8	7.6	0.0120
19	2	60.2	5.8	68.8	11.0	0.1700

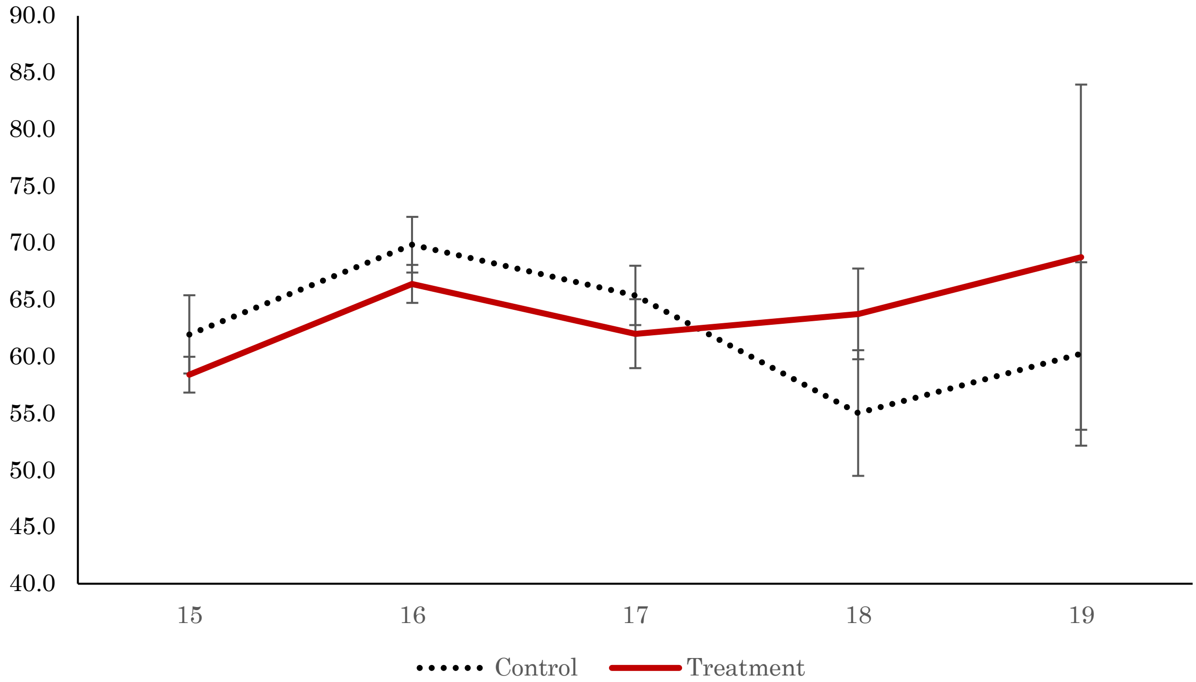

Figure 2. Average feed consumption (gram/bird/day) of pullets by week age in the study

- ***Egg production in layers***

The number of eggs from layer per day could be calculated from the aggregated report by week to make the number more meaningful. Table 3 and Figure 3 show this result. Poisson regression revealed that the amount of egg/bird/day in treatment group would be 1.0036 time of that in control group statistically significantly (p= 0.016). It can be simply understood that in the case we have the same number of layer (i.e., 1000) and the control group can produce 1000 egg per day, then the treatment group with the same number of layers would produce 1008.4 eggs. That means using MICRO – COMPLETE can increase egg production in layer.

Table 3. Average egg production (egg/bird/day) of layer by weeks in the study

Week age	Number of data	Control group Mean	Control group SD	Treatment group Mean	Treatment group SD
24	2	0.847	0.010	0.862	0.006
25	7	0.900	0.018	0.897	0.012
26	7	0.942	0.039	0.922	0.001
27	7	0.936	0.000	0.936	0.006
28	7	0.934	0.003	0.944	0.001
29	7	0.930	0.010	0.946	0.001
30	5	**0.927**	0.000	**0.945**	0.004

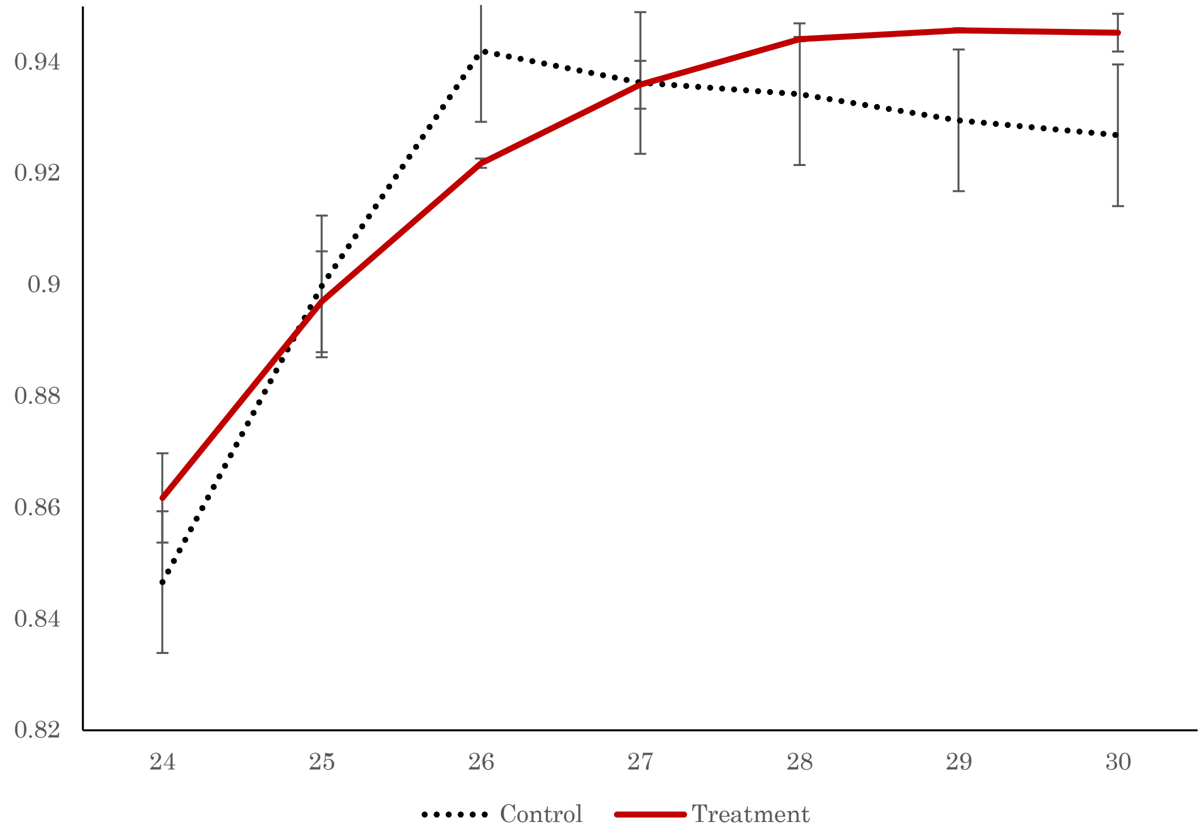

Figure 3. Average egg production (egg/bird/day) of layer by weeks in the study

- ***Mortality***

Number of deaths per 1000 bird per day can be seen in Table 4 and Figure 4 for pullets and Table 5 and Figure 5 for layer. It can be seen that mortality in treatment group might be slightly higher than the control group, especially for layers. In layer, the mortality in treatment group is 1.2 times more than that of control group non-statistically significant ($p=0.051$).

Table 4. Average number of deaths per 1000 pullets per day by week in the study

Week age	Number of data	Control group		Treatment group	
		Mean	SD	Mean	SD
15	12	1.196	2.649	0.515	0.343
16	14	0.440	0.349	0.257	0.207
17	14	0.200	0.201	0.207	0.191
18	14	0.166	0.159	0.207	0.236
19	2	0.241	0.341	0.353	0.277
p-value			0.1480		

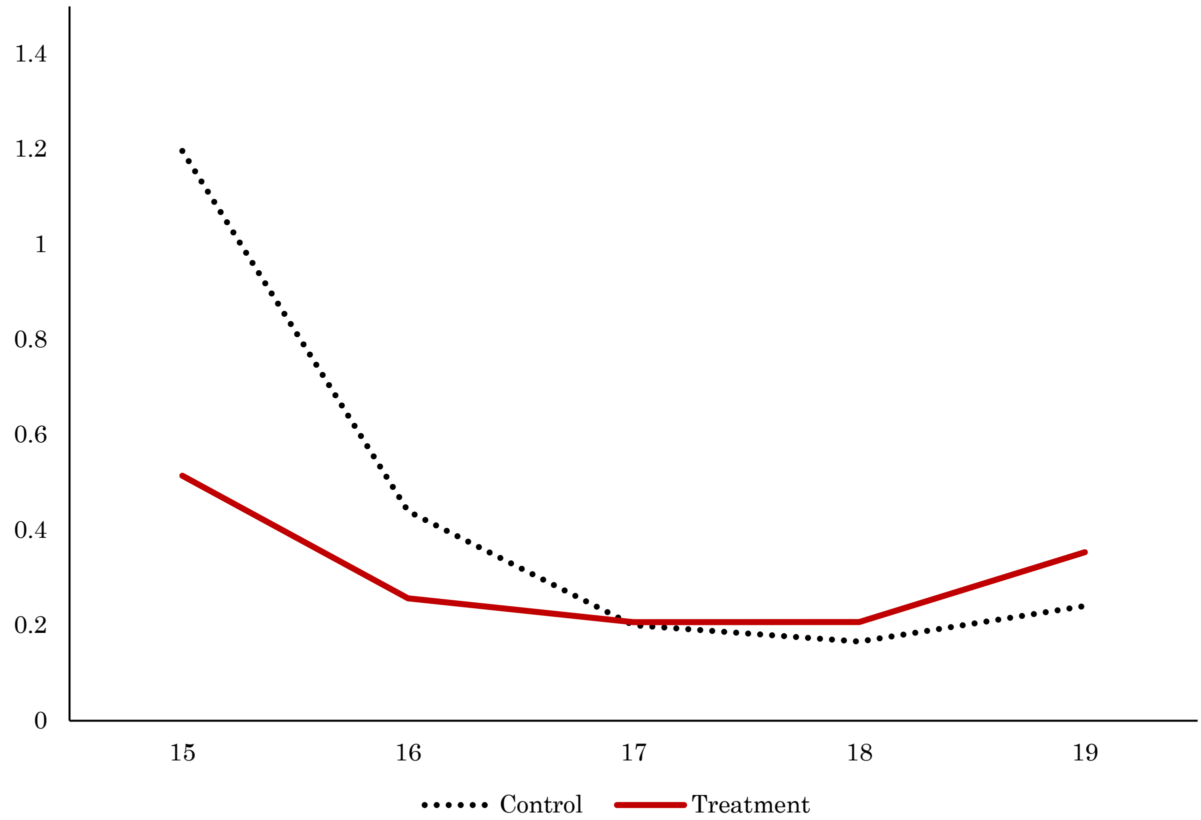

Figure 4. Average number of deaths per 1000 pullets per day by week in the study

Table 5. Average number of deaths per 1000 layers per day by week in the study

Week age	Number of data	Control group Mean	Control group SD	Treatment group Mean	Treatment group SD
24	2	0.400	0.000	0.222	0.000
25	7	0.121	0.102	0.235	0.076
26	7	0.178	0.057	0.216	0.048
27	7	0.166	0.056	0.191	0.071
28	7	0.223	0.082	0.230	0.087
29	7	0.249	0.051	0.243	0.051
30	5	0.125	0.086	0.296	0.068
p-value			0.051		

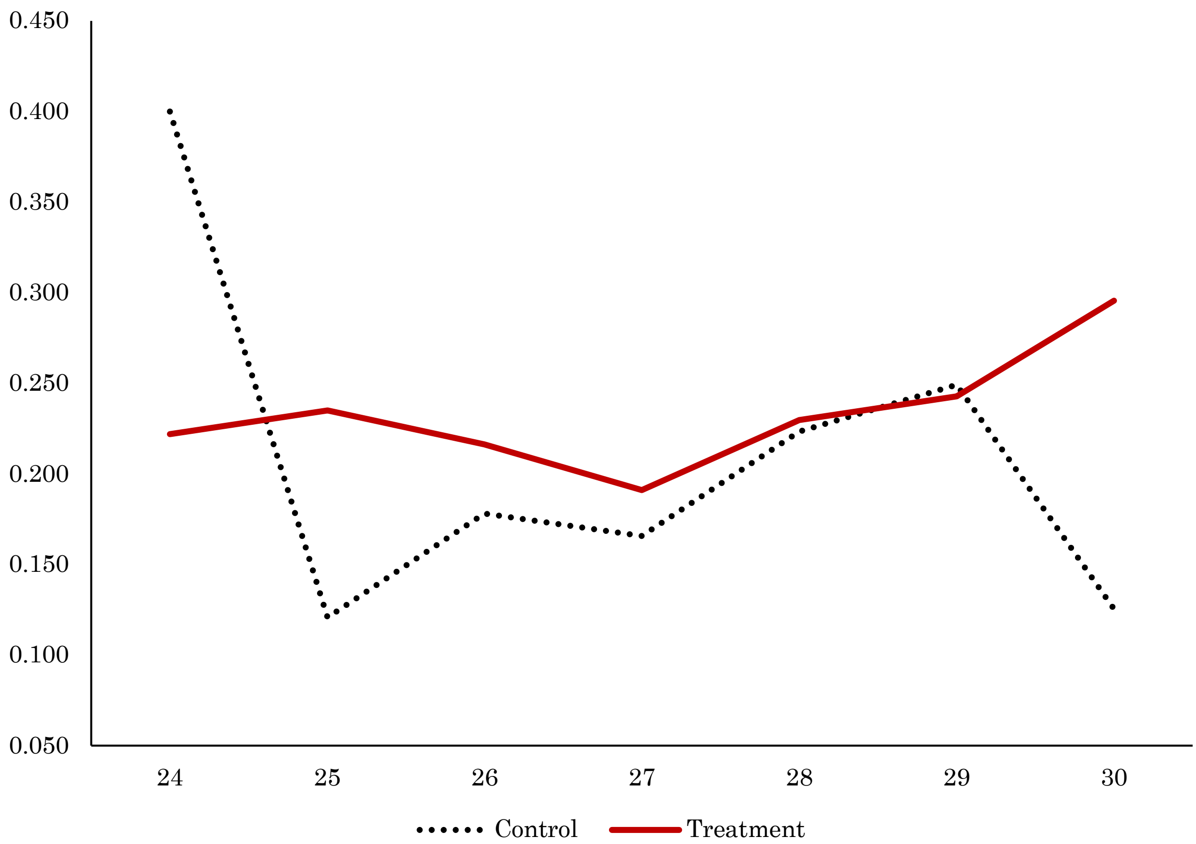

Figure 5. Average number of deaths per 1000 layers per day by week in the study

- ***Fecal score***

Feces from both groups were evaluated and classified into scores. Table 6 and Figure 6 show the distribution of these scores. Statistical analysis found that there was significant difference from median score of feces, i.e., the control group had higher score than the score of treatment groups in both pullet and layer. Table 7, Figures 7 and 8 show the mean scores of these groups. In general, using MICRO – COMPLETE can lead to improve fecal status of both layers, pullets.

Table 6. Distribution of scores of examined feces from pullets and layers in the study

	Pullets			Layers		
Score	Control	Treatment	Total	Control	Treatment	Total
0	0	1	1	49	194	243
1	1,729	1,824	3,553	521	613	1,134
2	465	379	844	433	283	716
3	46	36	82	117	30	147
Total	2,240	2,240	4,480	1,120	1,120	2,240
p- value	**0.012**			**0.0001**		

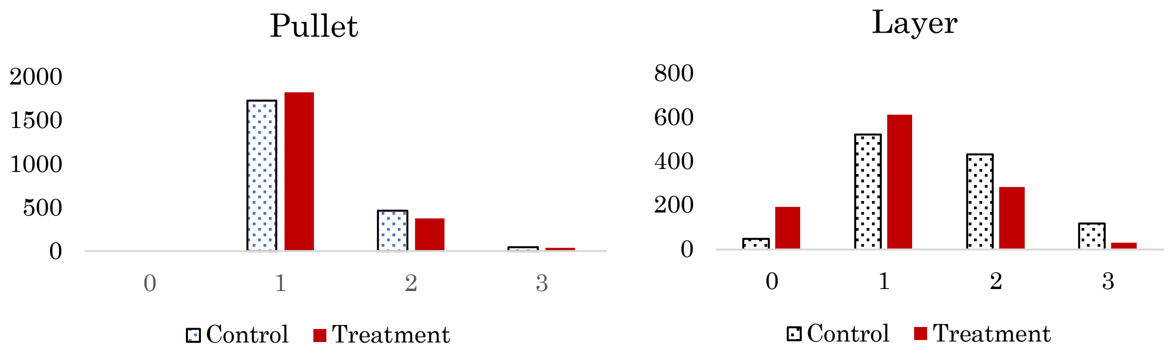

Figure 6. Distribution of scores of examined feces from pullets and layers in the study

Table 7. Distribution of scores of examined feces from pullets and layers in the study

		Pullet						**Layer**			
		Control		Treatment				Control		Treatment	
wk.	n	Mean	SD	Mean	SD	*wk.*	n	Mean	SD	Mean	SD
15	480	1.2	0.5	1.2	0.5	*24*	80	1.5	0.7	1.2	0.7
16	560	1.3	0.5	1.3	0.5	*25*	280	1.6	0.7	1.5	0.6
17	560	1.2	0.4	1.2	0.4	*26*	280	1.6	0.8	1.2	0.7
18	560	1.2	0.4	1.2	0.4	*27*	280	1.4	0.7	1.0	0.7
19	80	1.4	0.6	1.2	0.4	*28*	200	1.7	0.8	0.7	0.8

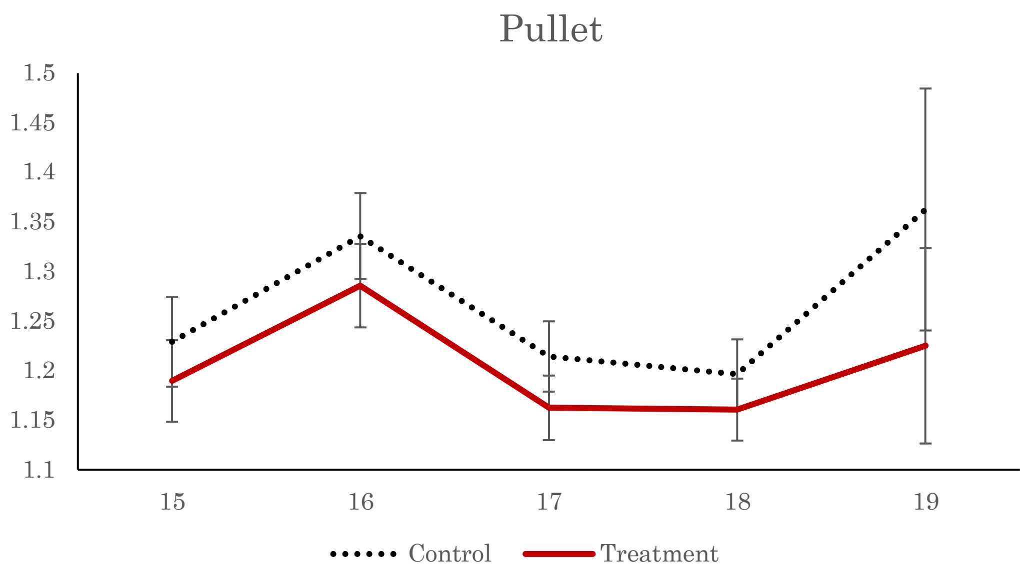

Figure 7. Mean scores with 95% confident interval of examined feces from pullets in the study

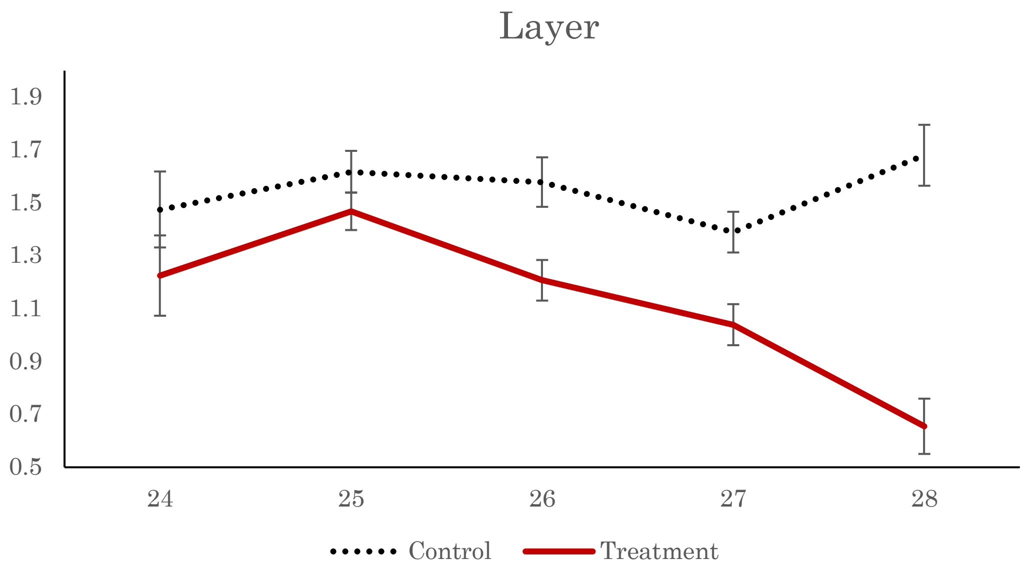

Figure 8. Mean scores with 95% confident interval of examined feces from layers in the study

- ***Intestinal bacterial enumeration***

No *Clostridium* was detected, so no statistics was carried out. Due to the balanced number of pullets (5 birds) and layers (5 birds) in both control and experimental groups, statistics was only done on control and treatment groups before and after PROBYN supplementation. Factors of breeding and chicken type were the same and then were not considered for analysis.

Table 8. Number of bacteria (log scale) in a gram of feces in 2 groups before product supplement and 4 weeks after supplement for each type of chicken

			N	***Lactobacillus***		***E. coli***		***Bacillus***	
				log	SE	log	SE	log	SE
Before	Pullet	Control	5	12.89	1.71	1.35	0.55	5.58	1.44
		Treatment	5	15.23	1.52	5.44	1.13	7.43	0.46
	Layer	Control	5	12.24	1.50	1.39	0.91	5.51	0.28
		Treatment	5	11.77	1.53	3.80	1.44	3.49	1.45
	Both	Control	**10**	12.57	1.08	**1.37**	0.43	5.54	0.69
		Treatment	**10**	13.50	1.17	**4.62**	1.46	5.46	0.97
	p-value			**0.5637**		**0.0056**		**0.9438**	
After	Pullet	Control	5	13.16	0.70	0.38	0.23	6.83	1.78
		Treatment	5	12.02	0.62	0.79	0.76	4.14	1.69
	Layer	Control	5	13.92	0.49	3.43	0.87	5.84	2.46
		Treatment	5	13.49	0.60	3.11	0.92	7.45	1.90
	Both	Control	**10**	13.54	0.42	**1.91**	0.66	6.34	1.44
		Treatment	**10**	12.75	0.48	**1.95**	0.68	5.80	1.32
	p-value			**0.2327**		**0.9627**		**0.7849**	

There was no significant difference in the number of *Lactobacillus* and *Bacillus* at the sampling time in both two groups. Regarding to the amount of *E. coli* before supplement, the number of *E. coli* in the treatment group was higher than that in the control group. However, after 4 weeks of treatment, the number of *E. coli* found in the experimental group was significantly decreasing to be equal to the control group. Bacterial numbers of *Lactobacillus*, *E. coli, Bacillus* in pullet, layer, before and after can be seen in Figure 9-11. Thus, using MICRO – COMPLETE can improve microflora in chicken gut.

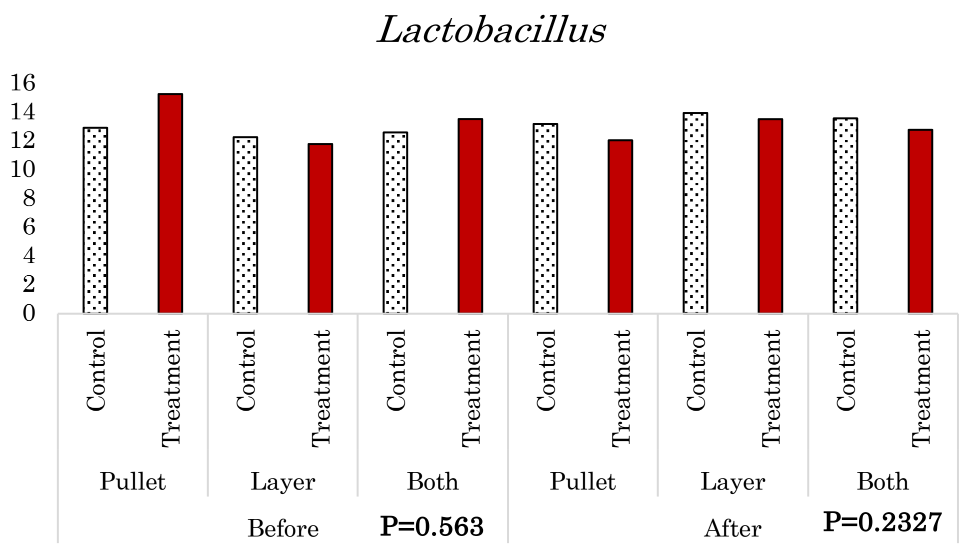

Figure 9. Number of *Lactobacillus* (logarite scale) in a gram feces before/after supplement in 2 types of chickens from 2 groups

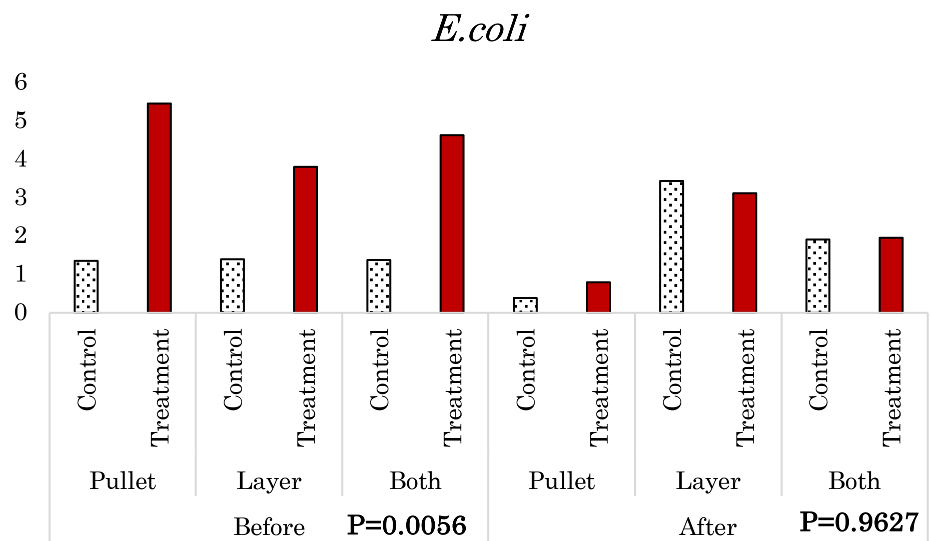

Figure 10. Number of *E.coli* (logarite scale) in a gram feces before/after supplement in 2 types of chickens from 2 groups

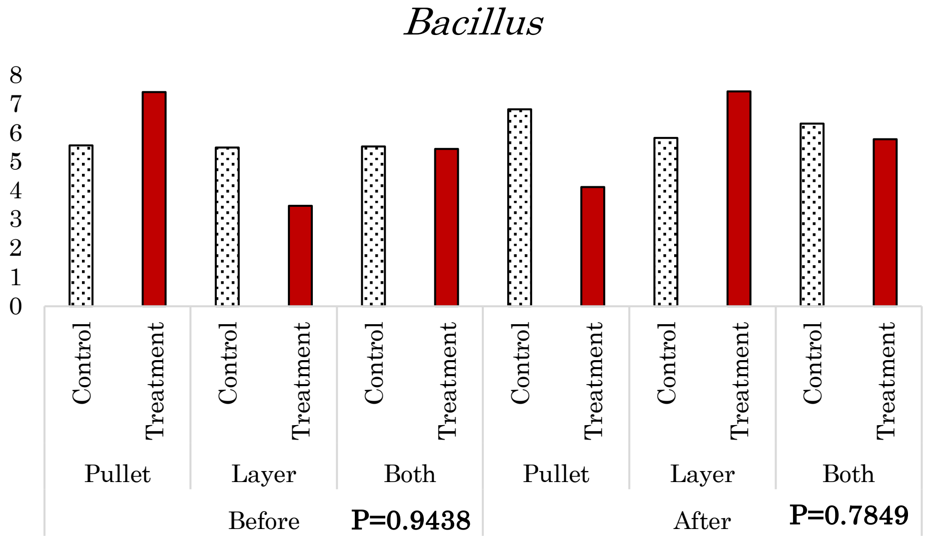

Figure 11. Number of *Bacillus* (logarite scale) in a gram feces before/after supplement in 2 types of chickens from 2 groups

- ***Villus height and crypt depth in the small intestine***

After PROBYN supplementing 4 weeks, the length of villi in small intestine (duodenum section) was improved. It was seen before supplement, the length in treatment group was shorter significantly but after that it was improving to be the same with control group. This pattern was also seen in the crypt depth. Table 9, Figures 12 and 13 show this pattern. It proved that using MICRO – COMPLETE can improve villus height and crypt depth in the small intestine of chicken.

Table 9. Villus height and crypt depth in the small intestine of chicken before/after supplement in 2 types of chicken and 2 groups

				Villus height		Crypt depth	
			N	micrometer	SD	micrometer	SD
Before	Pullet	Control	5	1321.6	138.8	264.6	30.5
		Treatment	5	1118.4	53.9	201.2	27.5
	Layer	Control	5	1347	53.7	299.0	38.3
		Treatment	5	1259	319.4	201.8	61.1
	Both	Control	10	1334.3	100.1	281.8	37.3
		Treatment	10	1188.7	228.3	201.5	44.7
After	Pullet	Control	5	1175.4	278.5	239.0	62.4
		Treatment	5	1323	93.5	265.8	146.6
	Layer	Control	5	1257.8	110.9	272.0	80.2
		Treatment	5	1240.2	160.5	207.4	36.9
	Both	Control	10	1216.6	204.5	255.5	69.9
		Treatment	10	1281.6	131.3	236.6	105.4

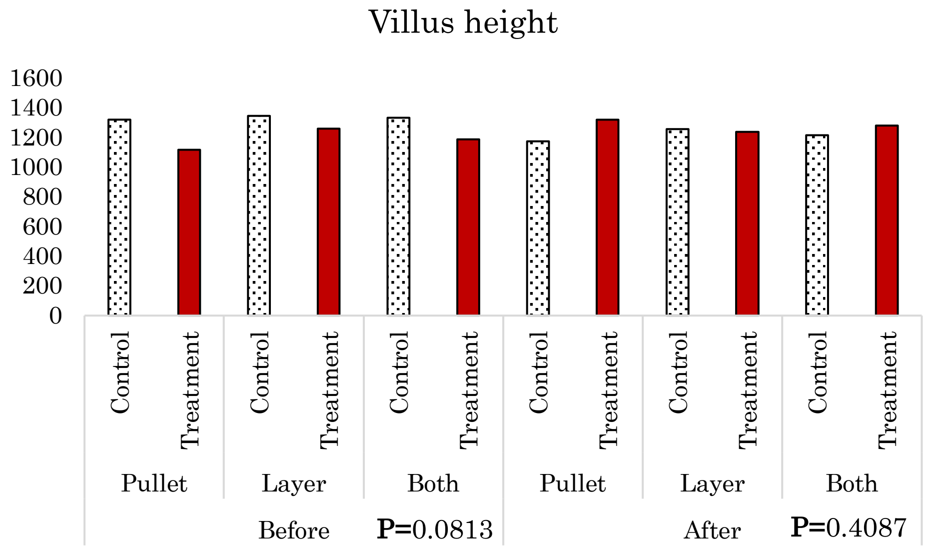

Figure 12. Villus height in the small intestine of chicken before/after supplement in 2 types of chicken and 2 groups

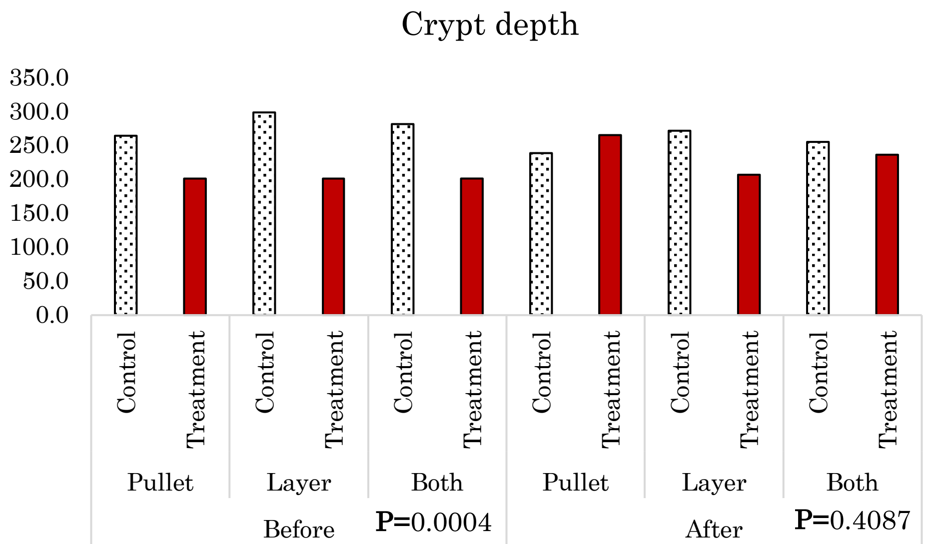

Figure 12. Crypt depth in the small intestine of chicken before/after supplement in 2 types of chicken and 2 groups

Conclusions

MICRO – COMPLETE supplement for pullets and layers could show some benefits on by

- *Higher egg production*
- *Better fecal score*
- *Improve intestinal microflora data by reduction of E.coli*
- *Improve villi height and Crypt depth of gut.*

Thus, this product is recommended to use on chicken farms.

Appendix – Statistical output

```
. * Fecal score
. use "D:\workplace\project\NL group\PROBYN - BRENNTAG\moi\diemphan.dta", clear
. tab type
       type |      Freq.     Percent        Cum.
------------+-----------------------------------
      layer |      2,240       33.33       33.33
     pullet |      4,480       66.67      100.00
------------+-----------------------------------
      Total |      6,720      100.00
. tab type breed
           |               breed
      type |    HYLINE  ISA BOV..  LOHMANN.. |     Total
-----------+---------------------------------+----------
     layer |         0      1,120      1,120 |     2,240
    pullet |     2,240          0      2,240 |     4,480
-----------+---------------------------------+----------
     Total |     2,240      1,120      3,360 |     6,720
. tab fecal_x   treatment

           |       treatment
   fecal_x |         1          2 |     Total
-----------+----------------------+----------
         0 |        49        195 |       244
         1 |     2,250      2,437 |     4,687
         2 |       898        662 |     1,560
         3 |       163         66 |       229
-----------+----------------------+----------
     Total |     3,360      3,360 |     6,720


. tab fecal_x treatment if type=="pullet"

           |       treatment
   fecal_x |         1          2 |     Total
-----------+----------------------+----------
         0 |         0          1 |         1
         1 |     1,729      1,824 |     3,553
         2 |       465        379 |       844
         3 |        46         36 |        82
-----------+----------------------+----------
     Total |     2,240      2,240 |     4,480


. tab fecal_x  treatment if type=="ga_de"

           |       treatment
   fecal_x |         1          2 |     Total
-----------+----------------------+----------
         0 |        49        194 |       243
         1 |       521        613 |     1,134
         2 |       433        283 |       716
         3 |       117         30 |       147
-----------+----------------------+----------
     Total |     1,120      1,120 |     2,240

. * So sanh diem phan
. kwallis fecal_x if type=="pullet", by(treatment)

Kruskal-Wallis equality-of-populations rank test

  +-----------------------------+
  | treatm~t |   Obs | Rank Sum |
  |----------+-------+----------|
  |        1 | 2,240 | 5.13e+06 |
  |        2 | 2,240 | 4.91e+06 |
  +-----------------------------+

chi-squared =     6.310 with 1 d.f.
probability =     0.0120

chi-squared with ties =    12.761 with 1 d.f.
probability =     0.0004
```

```
. kwallis fecal_x if type=="ga_de", by(treatment)

Kruskal-Wallis equality-of-populations rank test

  +-----------------------------+
  | treatm~t |   Obs | Rank Sum |
  |----------+-------+----------|
  |        1 | 1,120 | 1.43e+06 |
  |        2 | 1,120 | 1.08e+06 |
  +-----------------------------+

chi-squared =   135.706 with 1 d.f.
probability =     0.0001

chi-squared with ties =   162.321 with 1 d.f.
probability =     0.0001

. * Fecal score by time
. sort age
. by age: sum fecal_x if type=="pullet" & treatment==1
------------------------------------------------------------------------------------------
-> age = 15
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        480    1.229167    .5063102          1          3
------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        560    1.335714    .5229709          1          3
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        560    1.214286    .4277614          1          3
------------------------------------------------------------------------------------------
-> age = 18
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        560    1.196429    .4237849          1          3
------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |         80      1.3625     .556748          1          3
------------------------------------------------------------------------------------------

. sort age
. by age: sum fecal_x if type=="pullet" & treatment==2
------------------------------------------------------------------------------------------
-> age = 15
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        480    1.189583    .4608876          0          3
------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        560    1.285714    .5080492          1          3
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        560      1.1625    .3927166          1          3
------------------------------------------------------------------------------------------
-> age = 18
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        560    1.160714     .377203          1          3
------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |         80       1.225    .4493314          1          3
------------------------------------------------------------------------------------------
. sort age
```

```
. by age: sum fecal_x if type=="ga_de" & treatment==1

-> age = 24

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |         80       1.475    .6555508          0          3
------------------------------------------------------------------------------------------
-> age = 25

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        280    1.617857    .6723167          0          3
------------------------------------------------------------------------------------------
-> age = 26
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        280    1.578571    .7993533          0          3
------------------------------------------------------------------------------------------
-> age = 27
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        280    1.389286    .6573757          0          3
------------------------------------------------------------------------------------------
-> age = 28
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
     fecal_x |        200        1.68    .8312973          0          3

. * **********************************
. * Pullet weight
. **********************************
. use "D:\workplace\project\NL group\PROBYN - BRENNTAG\moi\weight_pullet.dta", clear

. sort age
. by age: sum weight if treatment ==1
------------------------------------------------------------------------------------------
-> age = 15

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80      943.25    128.2381        660       1200
------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80     1085.25    105.8776        840       1300
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80     1160.25    86.58025        930       1390
------------------------------------------------------------------------------------------
-> age = 18

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80      1179.5    109.8203        960       1470
------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80    1254.875    130.0145        910       1510
.
. sort age
. by age: sum weight if treatment ==2
------------------------------------------------------------------------------------------
-> age = 15
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80      980.75    109.2179        600       1200
------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80    1067.375     115.985        790       1290
```

```
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80    1128.375    105.3679        880       1360
------------------------------------------------------------------------------------------
-> age = 18
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80    1184.988    107.9657        900       1400
------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      weight |         80     1247.75    108.9649        950       1480

. oneway weight treatment if age==15, tabulate

            |          Summary of weight
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      943.25   128.23806          80
          2 |      980.75   109.21788          80
------------+------------------------------------
      Total |         962   120.21365         160

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups           56250      1         56250      3.96     0.0482
 Within groups         2241510    158    14186.7722
------------------------------------------------------------------------
    Total              2297760    159    14451.3208

Bartlett's test for equal variances:  chi2(1) =   2.0147  Prob>chi2 = 0.156

. oneway weight treatment if age==16, tabulate

            |          Summary of weight
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |     1085.25   105.87759          80
          2 |    1067.375   115.98498          80
------------+------------------------------------
      Total |   1076.3125   111.05906         160

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       12780.625      1    12780.625      1.04     0.3102
 Within groups      1948343.75    158   12331.2896
------------------------------------------------------------------------
    Total           1961124.38    159   12334.1156

Bartlett's test for equal variances:  chi2(1) =   0.6517  Prob>chi2 = 0.420

. oneway weight treatment if age==17, tabulate

            |          Summary of weight
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |     1160.25   86.580247          80
          2 |    1128.375   105.36788          80
------------+------------------------------------
      Total |   1144.3125    97.44937         160

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       40640.625      1    40640.625      4.37     0.0382
 Within groups      1469283.75    158   9299.26424
------------------------------------------------------------------------
    Total           1509924.38    159   9496.37972

Bartlett's test for equal variances:  chi2(1) =   3.0084  Prob>chi2 = 0.083

. oneway weight treatment if age==18, tabulate
```

```
            |          Summary of weight
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      1179.5   109.82034          80
          2 |   1184.9875   107.96571          80
------------+------------------------------------
      Total |   1182.2438   108.58888         160

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      1204.50625      1   1204.50625      0.10     0.7504
 Within groups      1873650.99    158   11858.5506
------------------------------------------------------------------------
    Total           1874855.49    159    11791.544

Bartlett's test for equal variances:  chi2(1) =   0.0228  Prob>chi2 = 0.880

. oneway weight treatment if age==19, tabulate

            |          Summary of weight
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |    1254.875   130.01454          80
          2 |     1247.75   108.96492          80
------------+------------------------------------
      Total |   1251.3125   119.62794         160

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups        2030.625      1     2030.625      0.14     0.7077
 Within groups      2273393.75    158    14388.568
------------------------------------------------------------------------
    Total           2275424.38    159   14310.8451

Bartlett's test for equal variances:  chi2(1) =   2.4363  Prob>chi2 = 0.119

.
.
. oneway weight treatment , tabulate

            |          Summary of weight
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |    1124.625    154.4701         400
          2 |   1121.8475   143.02125         400
------------+------------------------------------
      Total |   1123.2362   148.76909         800

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      1542.90125      1   1542.90125      0.07     0.7919
 Within groups      17682119.4    798   22158.0444
------------------------------------------------------------------------
    Total           17683662.3    799   22132.2432

Bartlett's test for equal variances:  chi2(1) =   2.3608  Prob>chi2 = 0.124

. *******************************
. * Production parameter
. ****************************
.
. use "D:\workplace\project\NL group\PROBYN - BRENNTAG\moi\nangsuat.dta", clear

. tab treatment type
           |         type
 treatment |    pullet      layer |     Total
-----------+----------------------+----------
         1 |        56         42 |        98
         2 |        56         42 |        98
-----------+----------------------+----------
     Total |       112         84 |       196
. gen mortality = dead*1000/ number
```

```
. sum mortality

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |        196    .3067538    .6988599          0   9.588493

. * Pullet
. oneway feed_chick treatment if type=="pullet"

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .012721986      1   .012721986      0.00     0.9880
 Within groups      6186.89478    110    56.244498
------------------------------------------------------------------------
    Total            6186.9075    111   55.7379054

Bartlett's test for equal variances:  chi2(1) =   6.8149  Prob>chi2 = 0.009

. sort age
. by age: sum feed_chick if type=="pullet" & treatment==1
------------------------------------------------------------------------------------------
-> age = 15
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         12    61.95608    6.088112   51.36716    67.9565
------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         14    69.85103    4.680209   61.83182   82.13799
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         14    65.38815    4.987836   58.05573   72.16164
------------------------------------------------------------------------------------------
-> age = 18
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         14     55.0302     10.5595    38.0548    72.3589
------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |          2    60.23115    5.825034   56.11222   64.35007
------------------------------------------------------------------------------------------
. sort age

. by age: sum feed_chick if type=="pullet" & treatment==2
------------------------------------------------------------------------------------------
-> age = 15
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         12    58.40807    2.785887   54.54262    62.4171
------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         14    66.40149     3.19261   60.75572   72.27127
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         14     62.0185    5.791643   54.74738   72.28822
------------------------------------------------------------------------------------------
-> age = 18
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |         14    63.75837    7.625924    55.0228   76.46459

------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  feed_chick |          2     68.7531    10.96509   60.99961   76.50659
------------------------------------------------------------------------------------------
```

```
. ** feed/bird/day
. xi:  mixed feed_chick i.treatment   || day: if type=="pullet" & age==15
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)
Performing EM optimization:
Performing gradient-based optimization:

Iteration 0:   log likelihood = -67.337566
Iteration 1:   log likelihood = -67.337566

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =         24
Group variable: day                             Number of groups  =          6

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       6.85
Log likelihood = -67.337566                     Prob > chi2       =     0.0089

------------------------------------------------------------------------------
  feed_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |  -3.548011   1.355503    -2.62   0.009    -6.204748    -.891274
       _cons |   61.95608   1.582889    39.14   0.000     58.85368    65.05849
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   9.521052   7.147496      2.186171    41.46539
-----------------------------+------------------------------------------------
               var(Residual) |   11.02433   3.674777      5.736122    21.18781
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 5.98          Prob >= chibar2 = 0.0072

. xi:  mixed feed_chick i.treatment   || day: if type=="pullet" & age==16
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -77.107231
Iteration 1:   log likelihood = -77.106982
Iteration 2:   log likelihood = -77.106982

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =         28
Group variable: day                             Number of groups  =          7

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       6.63
Log likelihood = -77.106982                     Prob > chi2       =     0.0100

------------------------------------------------------------------------------
  feed_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |  -3.449532   1.339353    -2.58   0.010    -6.074615   -.8244482
       _cons |   69.85103   1.109936    62.93   0.000     67.67559    72.02646
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   2.345167   3.087486      .1776399    30.96045
-----------------------------+------------------------------------------------
               var(Residual) |   12.55706   3.875193      6.858065    22.99188
```

```
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.89          Prob >= chibar2 = 0.1729

. xi:  mixed feed_chick i.treatment   || day: if type=="pullet" & age==17
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -82.547269
Iteration 1:   log likelihood = -82.547269

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =         28
Group variable: day                             Number of groups  =          7

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       5.40
Log likelihood = -82.547269                     Prob > chi2       =     0.0202

-------------------------------------------------------------------------------
   feed_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Itreatment_2 |  -3.369651   1.450645    -2.32   0.020    -6.212863   -.5264395
        _cons |   65.38815   1.680095    38.92   0.000     62.09522    68.68108
-------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   12.39374   8.668021      3.146902    48.81145
-----------------------------+------------------------------------------------
               var(Residual) |   14.73059    4.54596      8.045143     26.9716
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 6.78          Prob >= chibar2 = 0.0046

. xi:  mixed feed_chick i.treatment   || day: if type=="pullet" & age==18
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -101.00425
Iteration 1:   log likelihood = -100.86182
Iteration 2:   log likelihood = -100.86167
Iteration 3:   log likelihood = -100.86167

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =         28
Group variable: day                             Number of groups  =          7

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       6.77
Log likelihood = -100.86167                     Prob > chi2       =     0.0093

-------------------------------------------------------------------------------
   feed_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Itreatment_2 |   8.728176   3.354521     2.60   0.009     2.153436    15.30292
        _cons |    55.0302   2.372004    23.20   0.000     50.38116    59.67924
-------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
```

```
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   6.17e-22   9.57e-21      3.85e-35    9.87e-09
-----------------------------+------------------------------------------------
               var(Residual) |   78.76966   21.05216      46.65142    133.0004
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.00          Prob >= chibar2 = 1.0000

. xi:  mixed feed_chick i.treatment   || day: if type=="pullet" & age==19
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -13.003432
Iteration 1:   log likelihood = -12.979481
Iteration 2:   log likelihood = -12.979203
Iteration 3:   log likelihood = -12.979203

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =          4
Group variable: day                             Number of groups  =          1

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       1.88
Log likelihood = -12.979203                     Prob > chi2       =     0.1698

-------------------------------------------------------------------------------
   feed_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Itreatment_2 |   8.521954   6.208146     1.37   0.170    -3.645789     20.6897
        _cons |   60.23115   4.389822    13.72   0.000     51.62725    68.83504
-------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   6.38e-22   3.31e-20      3.94e-66    1.03e+23
-----------------------------+------------------------------------------------
               var(Residual) |   38.54108   27.25575      9.637519    154.1283
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.00          Prob >= chibar2 = 1.0000

.
. ** ti lệ chết
. sort age

. by age: sum mortality if type=="pullet" & treatment==1

-----------------------------------------------------------------------------------------
-> age = 15

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   mortality |         12    1.196435    2.648763   .1580528   9.588493

-----------------------------------------------------------------------------------------
-> age = 16

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   mortality |         14     .439777    .3486647          0   1.438159

-----------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   mortality |         14    .2004355    .2008843          0   .7224274
-----------------------------------------------------------------------------------------
-> age = 18
```

```
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         14    .1662466    .1589028          0   .4823927
------------------------------------------------------------------------------------------
-> age = 19
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |          2    .2413127    .3412678          0   .4826255
------------------------------------------------------------------------------------------
. sort age

. by age: sum mortality if type=="pullet" & treatment==2

------------------------------------------------------------------------------------------
-> age = 15
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         12    .5145017    .3426951   .1560062     1.4068

------------------------------------------------------------------------------------------
-> age = 16
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         14    .2573365    .2072335          0    .784683
------------------------------------------------------------------------------------------
-> age = 17
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         14    .2069981    .1906118          0   .6261251
------------------------------------------------------------------------------------------
-> age = 18
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         14     .207471    .2359667          0   .7869678
-> age = 19

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |          2    .3533482    .2770867   .1574183   .5492781

------------------------------------------------------------------------------------------
. xi:  mixed mortality i.treatment   || day: if type=="pullet" & age==15
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -48.369839
Iteration 1:   log likelihood = -48.270052
Iteration 2:   log likelihood =  -48.27005

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =         24
Group variable: day                             Number of groups  =          6

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       0.85
Log likelihood =  -48.27005                     Prob > chi2       =     0.3556

------------------------------------------------------------------------------
    mortality |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
_Itreatment_2 |  -.6819335    .738181    -0.92   0.356    -2.128742    .7648748
        _cons |   1.196435   .5219728     2.29   0.022     .1733872    2.219483
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   1.22e-15   2.24e-14      2.59e-31    5.710322
```

```
-----------------------------+------------------------------------------------
               var(Residual) |   3.269468    .943814      1.856762     5.75702
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.00          Prob >= chibar2 = 1.0000

. xi:  mixed mortality i.treatment   || day: if type=="pullet" & age==16
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood =  -3.784376
Iteration 1:   log likelihood = -3.7220815
Iteration 2:   log likelihood = -3.7219685
Iteration 3:   log likelihood = -3.7219675
Iteration 4:   log likelihood = -3.7219675

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =        28
Group variable: day                             Number of groups   =         7

                                                Obs per group:
                                                              min =         4
                                                              avg =       4.0
                                                              max =         4

                                                Wald chi2(1)       =      3.05
Log likelihood = -3.7219675                     Prob > chi2        =    0.0807

-------------------------------------------------------------------------------
    mortality |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Itreatment_2 |  -.1824405   .1044584    -1.75   0.081    -.3871753    .0222942
        _cons |    .439777   .0738633     5.95   0.000     .2950077    .5845463
-------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   2.66e-17   4.06e-16      2.65e-30     .000267
-----------------------------+------------------------------------------------
               var(Residual) |   .0763809   .0204138      .0452367    .1289672
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.00          Prob >= chibar2 = 1.0000

. xi:  mixed mortality i.treatment   || day: if type=="pullet" & age==17
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood =  7.3301877
Iteration 1:   log likelihood =  7.3306834
Iteration 2:   log likelihood =  7.3306834

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =        28
Group variable: day                             Number of groups   =         7

                                                Obs per group:
                                                              min =         4
                                                              avg =       4.0
                                                              max =         4

                                                Wald chi2(1)       =      0.01
Log likelihood =  7.3306834                     Prob > chi2        =    0.9209

-------------------------------------------------------------------------------
    mortality |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Itreatment_2 |   .0065626   .0660529     0.10   0.921    -.1228987    .1360239
        _cons |   .2004355   .0538973     3.72   0.000     .0947988    .3060722
```

```
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |    .005064   .0071853      .0003138    .0817097
-----------------------------+------------------------------------------------
               var(Residual) |   .0305409   .0094251        .01668    .0559201
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.73          Prob >= chibar2 = 0.1958

. xi:  mixed mortality i.treatment   || day: if type=="pullet" & age==18
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood =   9.478674
Iteration 1:   log likelihood =   9.478674

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =         28
Group variable: day                             Number of groups  =          7

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       0.57
Log likelihood =   9.478674                     Prob > chi2       =     0.4485

------------------------------------------------------------------------------
    mortality |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |   .0412244   .0543953     0.76   0.449    -.0653884    .1478371
        _cons |   .1662466   .0623571     2.67   0.008     .0440289    .2884643
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   .0168629   .0118892      .0042344    .0671543
-----------------------------+------------------------------------------------
               var(Residual) |   .0207119   .0063918      .0113118    .0379233
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 6.54          Prob >= chibar2 = 0.0053

. xi:  mixed mortality i.treatment   || day: if type=="pullet" & age==19
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood =  .36024314
Iteration 1:   log likelihood =   .3767805
Iteration 2:   log likelihood =  .38446877
Iteration 3:   log likelihood =  .38447195
Iteration 4:   log likelihood =  .38447195

Computing standard errors:

Mixed-effects ML regression                     Number of obs     =          4
Group variable: day                             Number of groups  =          1

                                                Obs per group:
                                                              min =          4
                                                              avg =        4.0
                                                              max =          4

                                                Wald chi2(1)      =       0.26
Log likelihood =  .38447195                     Prob > chi2       =     0.6102
```

```
------------------------------------------------------------------------------
    mortality |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |   .1120355   .2197958     0.51   0.610    -.3187563    .5428272
        _cons |   .2413127   .1554191     1.55   0.121     -.063303    .5459285
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   6.42e-19   2.70e-17      1.03e-54   4.02e+17
-----------------------------+------------------------------------------------
               var(Residual) |   .0483102   .0341609       .012082   .1931689
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 1.0e-15       Prob >= chibar2 = 1.0000

.
.
. xi: mepoisson dead i.treatment i.age if type=="pullet", exposure(number) || house:
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)
i.age             _Iage_15-30         (naturally coded; _Iage_15 omitted)

Mixed-effects Poisson regression                Number of obs     =        112
Group variable:           house                 Number of groups  =          4

                                                Obs per group:
                                                              min =         28
                                                              avg =       28.0
                                                              max =         28

Integration method: mvaghermite                 Integration pts.  =          7

                                                Wald chi2(5)      =     213.18
Log likelihood = -462.05469                     Prob > chi2       =     0.0000
------------------------------------------------------------------------------
         dead |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |  -.4147057   .2863846    -1.45   0.148    -.9760091    .1465977
     _Iage_16 |   -.893524   .1095039    -8.16   0.000    -1.108148   -.6789003
     _Iage_17 |  -1.427437   .1332288   -10.71   0.000    -1.688561   -1.166314
     _Iage_18 |  -1.513149    .137886   -10.97   0.000      -1.7834   -1.242897
     _Iage_19 |  -1.047764   .2655705    -3.95   0.000    -1.568273   -.5272558
     _Iage_24 |          0  (omitted)
     _Iage_25 |          0  (omitted)
     _Iage_26 |          0  (omitted)
     _Iage_27 |          0  (omitted)
     _Iage_28 |          0  (omitted)
     _Iage_29 |          0  (omitted)
     _Iage_30 |          0  (omitted)
        _cons |  -6.924409   .2057493   -33.65   0.000     -7.32767   -6.521148
   ln(number) |          1  (exposure)
-------------+----------------------------------------------------------------
house        |
    var(_cons)|   .0736796   .0571773                      .0160988    .3372109
------------------------------------------------------------------------------
LR test vs. Poisson model: chibar2(01) = 34.16        Prob >= chibar2 = 0.0000

. * Ga de Layer
. ** luong thuc an / con/ nag
. sort age
. by age: sum feed_chick if type=="layer" & treatment==1

-> age = 24
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          2    113.3258    .0320559   113.3031   113.3484
---------------------------------------------------------------------------------------
-> age = 25
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    111.8521     2.22569   110.0587   114.5972
---------------------------------------------------------------------------------------
-> age = 26
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
```

```
  feed_chick |          7    115.6173    1.213996   114.6023   116.9317
------------------------------------------------------------------------------------------
-> age = 27
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    112.7311    2.577562   110.3482   116.9838
------------------------------------------------------------------------------------------
-> age = 28
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    112.7218    .0587439   112.6478   112.8088
------------------------------------------------------------------------------------------
-> age = 29
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    114.8359    2.445151    112.824   117.4759
------------------------------------------------------------------------------------------
-> age = 30
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          5    117.0881    .5913796   116.4405   117.5443

.  sum feed_chick if type=="layer" & treatment==1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |         42    113.9619    2.431764   110.0587   117.5443
-> age = 24
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          2    115.4299    .0181211   115.4171   115.4427
------------------------------------------------------------------------------------------
-> age = 25
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    115.5563    .0562106   115.4683   115.6326
------------------------------------------------------------------------------------------
-> age = 26
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    115.7393    .0574243   115.6584   115.8129
------------------------------------------------------------------------------------------
-> age = 27
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    115.8992    .0484394   115.8336   115.9627
------------------------------------------------------------------------------------------
-> age = 28
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    116.0626    .0641438   115.9886   116.1596
------------------------------------------------------------------------------------------
-> age = 29
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          7    116.2553    .0639399   116.1752   116.3467
------------------------------------------------------------------------------------------
-> age = 30
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |          5    116.4364    .0556084   116.3727   116.5136

. sum feed_chick if type=="layer" & treatment==2
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  feed_chick |         42    115.9436    .3120291   115.4171   116.5136

.
. xi:  mixed feed_chick i.treatment   || day: if type=="layer"
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood = -164.24238
Iteration 1:   log likelihood = -164.13562
```

```
Iteration 2:   log likelihood = -164.13555
Iteration 3:   log likelihood = -164.13555

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =        84
Group variable: day                             Number of groups   =        42

                                                Obs per group:
                                                              min =         2
                                                              avg =       2.0
                                                              max =         2

                                                Wald chi2(1)       =     31.62
Log likelihood = -164.13555                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
   feed_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |   1.981699    .352405     5.62   0.000     1.290998      2.6724
        _cons |   113.9619   .2642988   431.19   0.000     113.4439    114.4799
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   .3258881   .4554882      .0210552    5.044039
-----------------------------+------------------------------------------------
               var(Residual) |   2.607974   .5691062       1.70042    3.999913
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.52          Prob >= chibar2 = 0.2351

.
. ** ti lệ chết
. xi:  mixed mortality i.treatment   || day: if type=="layer"
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0:   log likelihood =  90.646613
Iteration 1:   log likelihood =  91.373376
Iteration 2:   log likelihood =  91.374887
Iteration 3:   log likelihood =  91.374887

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =        84
Group variable: day                             Number of groups   =        42

                                                Obs per group:
                                                              min =         2
                                                              avg =       2.0
                                                              max =         2

                                                Wald chi2(1)       =      5.41
Log likelihood =  91.374887                     Prob > chi2        =    0.0200

------------------------------------------------------------------------------
    mortality |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |   .0414022   .0177922     2.33   0.020     .0065302    .0762743
        _cons |   .1901021    .012581    15.11   0.000     .1654439    .2147604
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |   4.98e-25   3.61e-24      3.32e-31    7.46e-19
-----------------------------+------------------------------------------------
               var(Residual) |   .0066478   .0010258      .0049129    .0089954
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 0.00          Prob >= chibar2 = 1.0000
```

```
. sort age

. by age: sum mortality if type=="layer" & treatment==1
-> age = 24
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         2    .3999734    .0001131   .3998934   .4000534
------------------------------------------------------------------------------------------
-> age = 25
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .1207386    .1017847          0   .2668683
------------------------------------------------------------------------------------------
-> age = 26
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .1781168    .0574677   .0890115   .2671178
------------------------------------------------------------------------------------------
-> age = 27
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .1655943     .055867   .0891226   .2673916
------------------------------------------------------------------------------------------
-> age = 28
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .2232115    .0815082   .1338688    .357095
------------------------------------------------------------------------------------------
-> age = 29
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .2491318     .050569    .179011   .3128771
------------------------------------------------------------------------------------------
-> age = 30
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         5    .1253586    .0861069          0   .2238438


. sum mortality if type=="layer" & treatment==1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |        42    .1901021    .0944264          0   .4000534

. sort age

. by age: sum mortality if type=="layer" & treatment==2
-> age = 24
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         2    .2219805    .0000348   .2219559   .2220051
------------------------------------------------------------------------------------------
-> age = 25
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .2349063    .0756423   .1777146    .399698
------------------------------------------------------------------------------------------
-> age = 26
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .2162043     .047524   .1781103   .3115265
------------------------------------------------------------------------------------------
-> age = 27
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .1910417    .0714952   .0891941    .312082
------------------------------------------------------------------------------------------
-> age = 28
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .2295828    .0871525    .089222   .3126396
------------------------------------------------------------------------------------------
-> age = 29
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   mortality |         7    .2427391    .0507204   .1340483   .2684203
```

```
------------------------------------------------------------------------------------------
-> age = 30
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   mortality |          5    .2955806    .0679807   .2237937   .4031536

. sum mortality if type=="layer" & treatment==2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   mortality |         42    .2315044    .0685824   .0891941   .4031536

. xi: mepoisson dead i.treatment i.age if type=="layer", exposure(number) || house:

Mixed-effects Poisson regression                Number of obs     =         84
Group variable:           house                 Number of groups  =          2

                                                Obs per group:
                                                              min =         42
                                                              avg =       42.0
                                                              max =         42

Integration method: mvaghermite                 Integration pts.  =          7

                                                Wald chi2(7)      =      13.63
Log likelihood = -168.81188                     Prob > chi2       =     0.0581
-------------------------------------------------------------------------------
         dead |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
_Itreatment_2 |   .1968145    .100865     1.95   0.051    -.0008773    .3945063
     _Iage_16 |          0  (omitted)
     _Iage_17 |          0  (omitted)
     _Iage_18 |          0  (omitted)
     _Iage_19 |          0  (omitted)
     _Iage_24 |   .3902035   .2387276     1.63   0.102    -.0776941     .858101
     _Iage_25 |  -.1683544   .1978225    -0.85   0.395    -.5560794    .2193706
     _Iage_26 |    -.06527   .1934053    -0.34   0.736    -.4443375    .3137976
     _Iage_27 |  -.1657491   .1978225    -0.84   0.402     -.553474    .2219759
     _Iage_28 |   .0729502   .1880455     0.39   0.698    -.2956122    .4415125
     _Iage_29 |   .1557726   .1851043     0.84   0.400    -.2070252    .5185704
     _Iage_30 |          0  (omitted)
        _cons |  -8.569433   .1560225   -54.92   0.000    -8.875231   -8.263635
   ln(number) |          1  (exposure)
--------------+----------------------------------------------------------------
house         |
    var(_cons)|   9.44e-34   3.18e-18                             .           .
-------------------------------------------------------------------------------
LR test vs. Poisson model: chi2(0) = 1.7e-13             Prob > chi2 =      .

Note: LR test is conservative and provided only for reference.
.
. * Nang suat trung
. gen egg_18_n= egg_18 * 300
(112 missing values generated)
. gen egg_19_n= egg_19 * 300
(112 missing values generated)
. gen egg_20_n= egg_20 * 300
(112 missing values generated)
. gen egg_other_n= egg_other * 30
(112 missing values generated)
. gen egg_n = egg_18_n + egg_19_n + egg_20_n + egg_other_n
(112 missing values generated)
. *br egg_n  egg
. gen egg_chick = egg_n/ number
(112 missing values generated)
. sum egg_chick

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |         84    .9259671    .0258288    .839776   1.028862

. xi:  mixed egg_chick i.treatment   || day: if type=="layer"
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)
Performing EM optimization:

Performing gradient-based optimization:
```

```
Iteration 0:   log likelihood =  201.79088
Iteration 1:   log likelihood =  201.79088

Computing standard errors:

Mixed-effects ML regression                     Number of obs      =        84
Group variable: day                             Number of groups   =        42

                                                Obs per group:
                                                              min =         2
                                                              avg =       2.0
                                                              max =         2

                                                Wald chi2(1)       =      1.15
Log likelihood =  201.79088                     Prob > chi2        =    0.2827

------------------------------------------------------------------------------
    egg_chick |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |   .0033838   .0031498     1.07   0.283    -.0027897    .0095574
        _cons |   .9242752   .0039531   233.81   0.000     .9165273     .932023
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
day: Identity                |
                  var(_cons) |    .000448   .0001226       .000262     .000766
-----------------------------+------------------------------------------------
               var(Residual) |   .0002083   .0000455      .0001358    .0003195
------------------------------------------------------------------------------
LR test vs. linear model: chibar2(01) = 26.34         Prob >= chibar2 = 0.0000

. sort age
. by age: sum egg_chick if treatment==1
-> age = 24
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         2    .8466116    .0096669    .839776   .8534471
------------------------------------------------------------------------------------------
-> age = 25
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         7    .8997123    .0183657   .8671291   .9184355
------------------------------------------------------------------------------------------
-> age = 26
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         7    .9419901    .0388393   .9212693   1.028862
------------------------------------------------------------------------------------------
-> age = 27
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         7    .9362462    .0003399   .9357872   .9367055
------------------------------------------------------------------------------------------
-> age = 28
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         7    .9342347    .0027287   .9306789   .9372071
------------------------------------------------------------------------------------------
-> age = 29
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         7    .9295396    .0097904   .9152315   .9391771
------------------------------------------------------------------------------------------
-> age = 30
    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |         5    .9268546    .0002188   .9265476   .9270455


. sum egg_chick if treatment==1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   egg_chick |        42    .9242752    .0280231    .839776   1.028862
```

```
. sort age

. by age:sum egg_chick if treatment==2

-> age = 24
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          2    .8617288     .005786   .8576375   .8658201
-----------------------------------------------------------------------------------
-> age = 25
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          7    .8969626    .0122265   .8793356   .9072715
-----------------------------------------------------------------------------------
-> age = 26
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          7    .9218444    .0011292   .9208185   .9241865
-----------------------------------------------------------------------------------
-> age = 27
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          7    .9359199    .0058035   .9275595    .943312
-----------------------------------------------------------------------------------
-> age = 28
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          7    .9441244    .0005218   .9435225   .9449136
-----------------------------------------------------------------------------------
-> age = 29
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          7    .9456924    .0005201   .9450402   .9464357
-----------------------------------------------------------------------------------
-> age = 30
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |          5    .9452828    .0038681   .9383823   .9474109


. sum egg_chick if treatment==2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
   egg_chick |         42     .927659     .023651   .8576375   .9474109

.
. xi: poisson egg_n i.treatment i.age, exposure(number)
i.treatment       _Itreatment_1-2     (naturally coded; _Itreatment_1 omitted)
i.age             _Iage_15-30         (naturally coded; _Iage_15 omitted)
note: _Iage_16 omitted because of collinearity
note: _Iage_17 omitted because of collinearity
note: _Iage_18 omitted because of collinearity
note: _Iage_19 omitted because of collinearity
note: _Iage_30 omitted because of collinearity

Iteration 0:   log likelihood = -691.85076
Iteration 1:   log likelihood = -691.85076

Poisson regression                                Number of obs     =         84
                                                  LR chi2(7)        =     958.41
                                                  Prob > chi2       =     0.0000
Log likelihood = -691.85076                       Pseudo R2         =     0.4092

------------------------------------------------------------------------------
       egg_n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Itreatment_2 |   .0036315   .0015145     2.40   0.016     .0006631    .0065998
     _Iage_16 |          0  (omitted)
     _Iage_17 |          0  (omitted)
     _Iage_18 |          0  (omitted)
     _Iage_19 |          0  (omitted)
     _Iage_24 |  -.0915558   .0042171   -21.71   0.000    -.0998212   -.0832903
     _Iage_25 |  -.0411493   .0028843   -14.27   0.000    -.0468025   -.0354961
     _Iage_26 |  -.0044497   .0028629    -1.55   0.120    -.0100609    .0011615
     _Iage_27 |   .0000142    .002861     0.00   0.996    -.0055933    .0056217
     _Iage_28 |   .0033183   .0028599     1.16   0.246    -.0022869    .0089236
```

```
     _Iage_29 |   .0016524   .0028619     0.58   0.564    -.0039568    .0072616
     _Iage_30 |          0  (omitted)
        _cons |  -.0678839    .002315   -29.32   0.000    -.0724212   -.0633466
   ln(number) |          1  (exposure)
------------------------------------------------------------------------------

. *********************
. * LAB
. *****************************
. use "D:\workplace\project\NL group\PROBYN - BRENNTAG\moi\lab.dta", clear
. sum lab clos ecoli bacillus length deepth

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
         lab |         40     4710925     9970650       1000   5.00e+07
        clos |         40           0           0          0          0
       ecoli |         40     211.684    566.2926        .03       2400
    bacillus |         40     5740.75    14208.67          0      80000
      length |         40      1255.3    176.8356        717       1566
-------------+---------------------------------------------------------
      deepth |         40      243.85    73.14354        117        515
. tab treatment

  treatment |      Freq.     Percent        Cum.
------------+-----------------------------------
          1 |         20       50.00       50.00
          2 |         20       50.00      100.00
------------+-----------------------------------
      Total |         40      100.00
. tab time

       time |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |         20       50.00       50.00
          1 |         20       50.00      100.00
------------+-----------------------------------
      Total |         40      100.00
. gen lab_lg=log(lab+1)

. gen ecoli_lg=log(ecoli+1)

. gen baci_lg=log(bacillus+1)

. oneway lab_lg treatment if time==0 & type== "pullet", tabulate

            |          Summary of lab_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   12.894509   3.8136809           5
          2 |   15.233546    3.390111           5
------------+------------------------------------
      Total |   14.064027   3.6182531          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       13.677739      1    13.677739      1.05     0.3354
 Within groups      104.148058      8   13.0185072
------------------------------------------------------------------------
    Total           117.825797      9   13.0917552

Bartlett's test for equal variances:  chi2(1) =   0.0492  Prob>chi2 = 0.825

. oneway lab_lg treatment if time==0 & type== "ga_de", tabulate

            |          Summary of lab_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   12.237676   3.3591332           5
          2 |   11.767311   3.4178459           5
------------+------------------------------------
      Total |   12.002493   3.2044221          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .553106176      1   .553106176      0.05     0.8318
```

```
 Within groups      91.8617847      8   11.4827231
------------------------------------------------------------------------
    Total           92.4148909      9   10.2683212

Bartlett's test for equal variances:  chi2(1) =   0.0011  Prob>chi2 = 0.974

. oneway lab_lg treatment if time==0 , tabulate

            |         Summary of lab_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   12.566092   3.4057194          10
          2 |   13.500429   3.6928617          10
------------+------------------------------------
      Total |    13.03326   3.4905157          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       4.3649241      1    4.3649241      0.35     0.5637
 Within groups       227.12537     18   12.6180761
------------------------------------------------------------------------
    Total           231.490294     19   12.1836997

Bartlett's test for equal variances:  chi2(1) =   0.0558  Prob>chi2 = 0.813

.
. oneway lab_lg treatment if time==1 & type== "pullet", tabulate

            |         Summary of lab_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   13.161964   1.5748127           5
          2 |   12.019677   1.3903847           5
------------+------------------------------------
      Total |   12.590821   1.5244258          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      3.26204825      1   3.26204825      1.48     0.2587
 Within groups      17.6528189      8   2.20660236
------------------------------------------------------------------------
    Total           20.9148672      9   2.32387413

Bartlett's test for equal variances:  chi2(1) =   0.0550  Prob>chi2 = 0.815

. oneway lab_lg treatment if time==1 & type== "ga_de", tabulate

            |         Summary of lab_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   13.921755   1.0991682           5
          2 |   13.489073   1.3474382           5
------------+------------------------------------
      Total |   13.705414   1.1814811          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .468036014      1   .468036014      0.31     0.5932
 Within groups      12.0950425      8   1.51188031
------------------------------------------------------------------------
    Total           12.5630785      9   1.39589761

Bartlett's test for equal variances:  chi2(1) =   0.1465  Prob>chi2 = 0.702

. oneway lab_lg treatment if time==1 , tabulate

            |         Summary of lab_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |    13.54186   1.3414764          10
          2 |   12.754375   1.5052812          10
------------+------------------------------------
      Total |   13.148117   1.4453107          20
```

```
                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      3.10066184      1   3.10066184      1.53     0.2327
 Within groups       36.588874     18   2.03271522
------------------------------------------------------------------------
    Total           39.6895359     19   2.08892294

Bartlett's test for equal variances:  chi2(1) =   0.1129  Prob>chi2 = 0.737

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.
. oneway ecoli_lg treatment if time==0 & type== "pullet", tabulate

            |         Summary of ecoli_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   1.3516375   1.2243815           5
          2 |    5.442955   2.5278947           5
------------+------------------------------------
      Total |   3.3972962   2.8558836          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      41.8471966      1   41.8471966     10.61     0.0116
 Within groups      31.5574459      8   3.94468074
------------------------------------------------------------------------
    Total           73.4046425      9   8.15607139

Bartlett's test for equal variances:  chi2(1) =   1.7248  Prob>chi2 = 0.189

. oneway ecoli_lg treatment if time==0 & type== "ga_de", tabulate

            |         Summary of ecoli_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   1.3928231   2.0238123           5
          2 |   3.7969872   3.2117797           5
------------+------------------------------------
      Total |   2.5949051   2.8303002          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      14.4500127      1   14.4500127      2.01     0.1945
 Within groups      57.6453808      8    7.2056726
------------------------------------------------------------------------
    Total           72.0953934      9   8.01059927

Bartlett's test for equal variances:  chi2(1) =   0.7329  Prob>chi2 = 0.392

. oneway ecoli_lg treatment if time==0 , tabulate

            |         Summary of ecoli_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   1.3722303   1.5770558          10
          2 |   4.6199711   2.8596065          10
------------+------------------------------------
      Total |   2.9961007   2.7977359          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      52.7391012      1   52.7391012      9.89     0.0056
 Within groups      95.9800923     18   5.33222735
------------------------------------------------------------------------
    Total           148.719193     19   7.82732597

Bartlett's test for equal variances:  chi2(1) =   2.8567  Prob>chi2 = 0.091

.
. oneway ecoli_lg treatment if time==1 & type== "pullet", tabulate

            |         Summary of ecoli_lg
  treatment |        Mean   Std. Dev.       Freq.
```

```
------------+------------------------------------
          1 |   .38489054   .52424818           5
          2 |   .79367654   1.7086192           5
------------+------------------------------------
      Total |   .58928354   1.2108137          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .417764992      1   .417764992      0.26     0.6229
 Within groups      12.7768629      8   1.59710787
------------------------------------------------------------------------
    Total           13.1946279      9   1.46606977

Bartlett's test for equal variances:  chi2(1) =   4.1123  Prob>chi2 = 0.043

. oneway ecoli_lg treatment if time==1 & type== "ga_de", tabulate

            |         Summary of ecoli_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   3.4280105   1.9487536           5
          2 |    3.109359    2.051187           5
------------+------------------------------------
      Total |   3.2686847   1.8936702          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .253846972      1   .253846972      0.06     0.8075
 Within groups      32.0200352      8    4.0025044
------------------------------------------------------------------------
    Total           32.2738822      9   3.58598691

Bartlett's test for equal variances:  chi2(1) =   0.0093  Prob>chi2 = 0.923

. oneway ecoli_lg treatment if time==1, tabulate

            |         Summary of ecoli_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   1.9064505   2.0934117          10
          2 |   1.9515177   2.1580072          10
------------+------------------------------------
      Total |   1.9289841   2.0693816          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .010155282      1   .010155282      0.00     0.9627
 Within groups      81.3543083     18   4.51968379
------------------------------------------------------------------------
    Total           81.3644636     19   4.28234019

Bartlett's test for equal variances:  chi2(1) =   0.0079  Prob>chi2 = 0.929

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. oneway baci_lg treatment if time==0 & type== "pullet", tabulate

            |         Summary of baci_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   5.5807405   3.2165649           5
          2 |   7.4312957   1.0358898           5
------------+------------------------------------
      Total |   6.5060181   2.4549002          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      8.56138576      1   8.56138576      1.50     0.2556
 Within groups      45.6774305      8   5.70967881
------------------------------------------------------------------------
    Total           54.2388162      9   6.02653514
```

```
Bartlett's test for equal variances:  chi2(1) =   3.8300  Prob>chi2 = 0.050

. oneway baci_lg treatment if time==0 & type== "ga_de", tabulate

            |         Summary of baci_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   5.5069458   .62577732           5
          2 |   3.4857301   3.2342029           5
------------+------------------------------------
      Total |   4.4963379   2.4408547          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      10.2132825      1   10.2132825      1.88     0.2073
 Within groups      43.4066625      8   5.42583282
------------------------------------------------------------------------
    Total            53.619945      9   5.95777167

Bartlett's test for equal variances:  chi2(1) =   7.0126  Prob>chi2 = 0.008

. oneway baci_lg treatment if time==0 , tabulate

            |         Summary of baci_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   5.5438432   2.1849272          10
          2 |   5.4585129   3.0741081          10
------------+------------------------------------
      Total |    5.501178   2.5960784          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .036406297      1   .036406297      0.01     0.9438
 Within groups      128.016427     18   7.11202372
------------------------------------------------------------------------
    Total           128.052833     19   6.73962281

Bartlett's test for equal variances:  chi2(1) =   0.9752  Prob>chi2 = 0.323

.
. oneway baci_lg treatment if time==1 & type== "pullet", tabulate

            |         Summary of baci_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   6.8335362   3.9704928           5
          2 |   4.1366161   3.7827656           5
------------+------------------------------------
      Total |   5.4850762   3.9225836          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      18.1834452      1   18.1834452      1.21     0.3035
 Within groups      120.296514      8   15.0370643
------------------------------------------------------------------------
    Total            138.47996      9   15.3866622

Bartlett's test for equal variances:  chi2(1) =   0.0083  Prob>chi2 = 0.927

. oneway baci_lg treatment if time==1 & type== "ga_de", tabulate

            |         Summary of baci_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   5.8400364   5.4996778           5
          2 |   7.4542084   4.2527576           5
------------+------------------------------------
      Total |   6.6471224   4.7122004          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      6.51387797      1   6.51387797      0.27     0.6177
```

```
 Within groups      193.329616      8    24.166202
------------------------------------------------------------------------
    Total           199.843494      9   22.2048326

Bartlett's test for equal variances:  chi2(1) =   0.2325  Prob>chi2 = 0.630

. oneway baci_lg treatment if time==1 , tabulate

            |         Summary of baci_lg
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   6.3367863   4.5523215          10
          2 |   5.7954123   4.1779461          10
------------+------------------------------------
      Total |   6.0660993   4.2616726          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      1.46542938      1   1.46542938      0.08     0.7849
 Within groups      343.609781     18   19.0894323
------------------------------------------------------------------------
    Total            345.07521     19   18.1618532

Bartlett's test for equal variances:  chi2(1) =   0.0627  Prob>chi2 = 0.802

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. *************
.
. oneway length treatment if time==0 & type== "pullet", tabulate

            |          Summary of length
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      1321.6   138.83191           5
          2 |      1118.4   53.891558           5
------------+------------------------------------
      Total |        1220   146.03653          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups        103225.6      1     103225.6      9.31     0.0158
 Within groups         88714.4      8      11089.3
------------------------------------------------------------------------
    Total               191940      9   21326.6667

Bartlett's test for equal variances:  chi2(1) =   2.7982  Prob>chi2 = 0.094

. oneway length treatment if time==0 & type== "ga_de", tabulate

            |          Summary of length
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |        1347   53.744767           5
          2 |        1259   319.43779           5
------------+------------------------------------
      Total |        1303   220.87603          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups           19360      1        19360      0.37     0.5604
 Within groups          419716      8      52464.5
------------------------------------------------------------------------
    Total               439076      9   48786.2222

Bartlett's test for equal variances:  chi2(1) =   7.9437  Prob>chi2 = 0.005

. oneway length treatment if time==0 , tabulate

            |          Summary of length
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      1334.3   100.14661          10
          2 |      1188.7   228.32727          10
------------+------------------------------------
```

```
      Total |      1261.5    187.1477          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups        105996.8      1     105996.8      3.41     0.0813
 Within groups        559464.2     18   31081.3444
------------------------------------------------------------------------
    Total               665461     19   35024.2632

Bartlett's test for equal variances:  chi2(1) =   5.2343  Prob>chi2 = 0.022

.
. oneway length treatment if time==1 & type== "pullet", tabulate

            |          Summary of length
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      1175.4    278.4552           5
          2 |        1323   93.525398           5
------------+------------------------------------
      Total |      1249.2    210.7135          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups         54464.4      1      54464.4      1.26     0.2938
 Within groups        345137.2      8     43142.15
------------------------------------------------------------------------
    Total             399601.6      9   44400.1778

Bartlett's test for equal variances:  chi2(1) =   3.5894  Prob>chi2 = 0.058

. oneway length treatment if time==1 & type== "ga_de", tabulate

            |          Summary of length
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      1257.8   110.89274           5
          2 |      1240.2   160.46713           5
------------+------------------------------------
      Total |        1249   130.36786          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups           774.4      1        774.4      0.04     0.8451
 Within groups        152187.6      8     19023.45
------------------------------------------------------------------------
    Total               152962      9   16995.7778

Bartlett's test for equal variances:  chi2(1) =   0.4748  Prob>chi2 = 0.491

. oneway length treatment if time==1 , tabulate

            |          Summary of length
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |      1216.6   204.48102          10
          2 |      1281.6   131.28696          10
------------+------------------------------------
      Total |      1249.1   170.53535          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups           21125      1        21125      0.72     0.4087
 Within groups        531438.8     18   29524.3778
------------------------------------------------------------------------
    Total             552563.8     19   29082.3053

Bartlett's test for equal variances:  chi2(1) =   1.6219  Prob>chi2 = 0.203

. oneway deepth treatment if time==0 & type== "pullet", tabulate

            |          Summary of deepth
  treatment |        Mean   Std. Dev.       Freq.
```

```
------------+------------------------------------
          1 |       264.6   30.492622           5
          2 |       201.2   27.471804           5
------------+------------------------------------
      Total |       232.9    43.18809          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups         10048.9      1      10048.9     11.93     0.0086
 Within groups            6738      8       842.25
------------------------------------------------------------------------
    Total              16786.9      9   1865.21111

Bartlett's test for equal variances:  chi2(1) =   0.0386  Prob>chi2 = 0.844

. oneway deepth treatment if time==0 & type== "ga_de", tabulate

            |          Summary of deepth
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |         299   38.255719           5
          2 |       201.8   61.140821           5
------------+------------------------------------
      Total |       250.4    70.25857          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups         23619.6      1      23619.6      9.08     0.0167
 Within groups         20806.8      8      2600.85
------------------------------------------------------------------------
    Total              44426.4      9   4936.26667

Bartlett's test for equal variances:  chi2(1) =   0.7546  Prob>chi2 = 0.385

. oneway deepth treatment if time==0 , tabulate

            |          Summary of deepth
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |       281.8   37.314876          10
          2 |       201.5   44.687184          10
------------+------------------------------------
      Total |      241.65   57.466031          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups        32240.45      1     32240.45     19.02     0.0004
 Within groups         30504.1     18   1694.67222
------------------------------------------------------------------------
    Total             62744.55     19   3302.34474

Bartlett's test for equal variances:  chi2(1) =   0.2757  Prob>chi2 = 0.600

.
. oneway deepth treatment if time==1 & type== "pullet", tabulate

            |          Summary of deepth
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |         239   62.437969           5
          2 |       265.8   146.56637           5
------------+------------------------------------
      Total |       252.4    107.1429          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups          1795.6      1       1795.6      0.14     0.7166
 Within groups        101520.8      8      12690.1
------------------------------------------------------------------------
    Total             103316.4      9      11479.6

Bartlett's test for equal variances:  chi2(1) =   2.3248  Prob>chi2 = 0.127
```

```
. oneway deepth treatment if time==1 & type== "ga_de", tabulate

            |          Summary of deepth
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |         272   80.177927           5
          2 |       207.4   36.882245           5
------------+------------------------------------
      Total |       239.7   67.977202          10

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups         10432.9      1      10432.9      2.68     0.1403
 Within groups         31155.2      8       3894.4
------------------------------------------------------------------------
    Total              41588.1      9       4620.9

Bartlett's test for equal variances:  chi2(1) =   1.9578  Prob>chi2 = 0.162

. oneway deepth treatment if time==1 , tabulate

            |          Summary of deepth
  treatment |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |       255.5    69.94482          10
          2 |       236.6   105.35358          10
------------+------------------------------------
      Total |      246.05   87.572812          20

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups         1786.05      1      1786.05      0.22     0.6422
 Within groups        143924.9     18   7995.82778
------------------------------------------------------------------------
    Total            145710.95     19   7668.99737

Bartlett's test for equal variances:  chi2(1) =   1.3923  Prob>chi2 = 0.238

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