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Potential of Pili Pulp (Canarium ovatum Engl) as Feed Supplement for Quail Layers

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ABSTRACT

The potential of pili pulp (Canarium ovatum Engl.) as feed supplement for quail layers was evaluated through a feeding trial involving Japanese quails for 4 months. The treatments include (T1) pure commercial laying mass, (T2) 5% pili pulp and 95% commercial laying mass, w/w, (T3) 10% pili pulp and 90% commercial laying mass, and (T4) 15% pili pulp +85% commercial laying mass. Results showed that the total amount of feeds consumed for the 110 days was lowest in T3 followed by T4 while T2 and T1 are comparable to each other indicating that the addition of Pili pulp as supplements at 5% did not reduce the palatability of quail laying mass but increasing the amount to 10% and 15% will significantly decrease feed consumption. Quail layers feed with 85% laying mass + 15% Pili pulp attained early sexual maturity, consistently higher cumulative number of eggs and laying percentage. Similarly, 15% pili pulp results to heavier eggs both the egg yolks and whites but did not affect considerably the egg yolk color. Overall, the use of dried pili pulp meal as supplement for laying quails at the rate of 15% showed great potential in improving the laying performance of quail layers and increasing the size of eggs while lowering feed consumption. However, for future study, drying process of pili pulp should be improve to preserve and reduce the degradation of pigments so that it will improve the egg yolk color.

Keywords: *egg's physiological properties, feed supplement, laying performance, quail eggs, pili pulp*

INTRODUCTION

Quail birds production has gained enormous significance because it has high potential as an alternative to chicken farming, particularly in providing gainful employment, supplementary income and as a valuable source of meat and egg for human consumption. Quail farming is more prevalent and proves an entry point to animal production for most small and marginalized farmers. It could help families to supplement income as this small-scale poultry production could employ minimal family labor and, wherever possible, utilizes locally available feed resources.

Just like any fast-growing production system, quail farming faces several challenges that need to be addressed to sustain productivity. Factors affecting the success and sustainability of quail productions include availability of quality feeds with high cost, prevalence of diseases, and unfavorable environmental conditions for optimal growth and development of quails. In the study of Lin et al. (2007), he demonstrated that high environmental temperature is one of the important stressors affecting the productive performance of layers. The resultant heat stress comes from the interactions among air temperature, humidity, radiant heat, and air speed, where the air temperature plays a major role (Lin et al. 2007). The optimum temperature for laying hens is likely to be 18 to 22 °C (Charles 2002). When environmental temperature goes above, a wide range of changes was noted in egg production, egg quality traits, feed consumption, feed conversion ratio, rectal temperature, several hematological parameters, and many blood constituents, i.e., liver enzymes and thyroid hormones (El-Sheikh and Salama 2010). It is a well-known fact that in good nutrition conditions, stress does not cause great defects on the immune system; however, in case of inadequate intake of the necessary nutritional elements, side effects of exposure to intense stress appear (Kolb 1997).

In order to enhance productivity of quails especially quail layers, several strategies are being used which include improving feed and water use efficiency, good sanitation and stress prevention (Ayasan et al. 2005; Singh et al., 2009). For example, poultry farmers use growth promoters and supplements used to increase growth rate, improve the feed conversion, reduce morbidity and mortality due to clinical and subclinical diseases (Guclu, 2011). There are several growth promoters like feed supplement, prebiotics, probiotics, yeast culture, acidifiers and antibiotics which are utilized in poultry feed to improve digestion and to promote better performance for profitable poultry production (Ayasan et al. 2005;Yesilbag and Colpan, 2006). Feed supplement is an ingredient or combination of ingredients added to the basal feeds in non-therapeutic quantities for the purpose of promoting growth, lowering feed consumption, improving feed efficiency as well as protecting the birds against environmental stresses (Hassanein, and Soliman, 2010). It also prevents and controls diseases and makes end-products more homogeneous and of better quality. It also lowers the production cost (Bar et al., 2012). Probiotics are live microorganisms (mainly lactic acid bacteria or spore forming organisms) which assist in the establishment of intestinal population which are beneficial to the animal and antagonistic to harmful microbes. Potential of Canariumovatum pulp as source of natural antioxidant for egg enrichment

Pili(Canariumovatum Engl.) is indigenous to the Philippines. Pili fruit pulp is rich in fat, and oil can be obtained by manual extraction using a mechanical pulp press (Coronel, 1996). The exhausted paste referred as pomace (pulp), is the solid waste residue of such processing. Remnants consist of a mixture of peel and fibrous pulp. Typically, this by-product is turned as livestock feed and compost. Pulp contains bioactive compounds such as phenolics, sugars, minerals, organic acids and dietary fiber (Maranon, et al. 1954). The amount of phytochemicals is greater in waste products compared to the edible portion.

The pili pulp is similar in composition to avocado. It contains 28 to 36% oil, carbohydrates, and protein. Its color varies from yellow green to dark green, depending on the type of extraction. Pili pulp reveals fatty acid profiles and minor components such as the carotenoids, to copherols, and sterols that have specific potential for the nutraceutical industries (Pham and Dumandan, 2015). Carotenoids are chemically conjugated hydrocarbons that may be further classified as carotenes (i.e., without an oxygen atom) and xanthophylls with one or more oxygen atoms. Carotenes are synthesized only by plants. These are colorful plant pigments that the body can turn into vitamin A, and they are powerful antioxidants that can prevent some forms (Pham and Dumandan, 2015). Tocopherols have also received attention for their usefulness as antioxidants in clinical and nutritional applications. It is commonly called vitamin E that prevent some problems of the central nervous system when included in the diet. Some forms of tocopherol are also antioxidants because they help the body fight off chronic disease by helping to resist oxidation in the blood. The lipid sterols, specifically phytosterols, shown that they cause a fall in the absorption of cholesterol by competing with it and cause an increase in bile secretion (Paiva, and Russell, 1999). Various sterol oxidation products have been isolated from traditional medicines in China and the anti cancerous properties of many drugs can be attributed to them.

Based on the analyses of Pham and Dumandan (2015), pili pulp and pili oil contain several carotenoid in the form of lycopene, lutein, and zeaxanthin. The extraction of pili oil at different stages of maturity shows that the level of this pigment decreases as the seed matures, but it remains a substantial source of carotenoids. The major tocopherol, which is d-tocopherol, is higher in pili pulp oil. The alpha-tocopherol is considered the most active among the tocopherols, although the importance of the other tocopherols should not be dismissed. The sterol fraction is the highest minor component in the UM. It is higher in pili pulp than in the pili nut. Stigmasterol is the dominant sterol in pili nut oil (123.35 mg/100 g oil), whereas campesterol is dominant in pili pulp oil (484.92 mg/100 g oil). The presence of these phytosterols such as campesterol, b-silosterol, and stigmasterol makes pili pulp and nut oils potential products for the nutraceutical industry because of the pharmacological properties of these phytosterols.

Therefore, Pili pulp is a potential source of important minor components such as carotenoids, sterols and tocopherols, which could be source of nutraceutical for improvement of feed diets. Based on the previous studies, the nutritional value and quality of eggs could be improved by manipulating the bird's diet through improvements of the feed nutritional quality with presumptions that this will be reflected on the quality of eggs produced from these diets. This holds the promise of the beneficial effects of pili pulp and a sustainable way of producing value-added products on eggs. With the application of proper processing techniques, the nutritive value of pili pulp can be utilized as feed supplement for the purpose of improving the nutritional quality of eggs.Therefore this study was conducted to assess the effect of pili pulp on the laying performance of quails and some properties of its eggs. Specific objective was to evaluate the effects of pili pulp on feed consumption, the percent of eggs layed, number of eggs and size of eggs, yolk color, and Haugh unit of quail eggs.

MATERIALS AND METHODS

Experimental Design, Treatment and Feed Formulation

The experimental animals used in this study were Japanese quail (order Galli farmer and the Family Phasianides) which are commonly domesticated in the Philippines for egg production. A total of one hundred eighty (180) quail layers at four months old was obtained from local supplier and subjected to feeding trials. All birds were of the same age and breed. There are four treatments consist of the Control (T1) – Commercial quail laying mash(CF); T2-95% CF + 5% air dried pili pulp meal; T3-90% CF + 10% air dried pili pulp meal; and T4-85% CF + 15% air dried pili pulp meal. The pili pulp was sundried or oven-dried to at least 40% moisture content and milled to pass through 2 mm size. The experiment was laid out in completely randomized design. Each treatment was composed of forty-five (45) birds and with 15 birds housed in 1 cage as replication.

Feeding and Cultural Management

The experimental birds were feed with commercial quail layer mash mixed dried powdered pili pulp meal based on the proportion for each treatment identified in Table 1. Feeds were supplied thrice daily and water was made available always. Similarly the feed formulation used in the experiment was ad libitum for the whole duration of the experiment. The cages were cleaned daily to remove all droppings.

Housing Requirement

The birds were housed on cages made of wire mesh with dimension of 6 x 10 cm at 30 cm height. Fifteen (15) birds were assigned to each cages permitting each bird a 225 cm2 as the minimum requirement. The cages were maintained on appropriate floor slope to allow the eggs to roll at the front of the cage for collection from the pens two or three times each day. Watering and feeding trough were provided in each cages having a dimension of 12.0 cm long and 7 cm in diameter using plastic containers. The feeds and water were supplied from the outside of the cage. There were 12 cages for all the 4 treatment in 3 replications.

Laying Performance of Quails

The laying performance parameters were evaluated by determining the (i) number of eggs harvested per cage at daily basis, (ii) the fresh weight of eggs; the diameter of the eggs and (iv) the laying percentages as the quotient of dividing the number of eggs produced by the number of layers multiplied by the number of laying days per treatment.

Assessment of Quality of Quail Eggs

For egg quality, 2 eggs per cage was collected randomly every week from the onset of laying from all the 12 groups (4 treatments x 3 replicates). A total of 24 eggswere analyzed with the following parameter: (i) ggg yolk color using Hoffman La Roche color chart and (ii) Haugh unit, an indicator of albumin quality for bakery industry, will be calculated using following formula:

Haugh unit =100 x log (H+ 7.57 - 1.7 W0.37)

Where:

H=albumin height (mm); and W = egg weight in grams (Eisen, Bohren, &Mckean,1962) after determining albumin height by a micrometer (Saginomiya, TLM-N1010, Japan) and egg weight.

STATISTICAL ANALYSIS

Data collection on the number of eggs, weight of eggs, and the amount of feed leftovers were collected on a daily basis. Weight of egg yolk, egg white, color of egg yolk was collected on a weekly interval from 2 representative eggs from each cages. The data on the daily number of eggs were totaled for weekly interval while the weight of eggs and the amount of leftover feeds were converted into weekly average. These data were then subjected to analysis of variance based on CRD with equal replication. Parameters with significant differences from ANOVA was be subjected to treatment mean comparison using HSD test at 5% level of significance.

Results And Discussions

Feed Consumption of Quail Layers

The feed consumption of quail layers was assessed indirectly based on the amount of feed leftovers on the daily basis since all cages are given equal amounts of feeds. The amount consumed was calculated by subtracting the amount of leftovers from the amount of feed supplied at 600g per cage daily. Based on total weekly consumption of feeds, there was a significant difference at start of the feeding trial and intermittently during the entire duration of the experiment (Table 1). Regardless whether significant differences exist, T3 was consistently consumed less amount of feeds compared to T1 and T2. Quails in T4 also consumed less than T2 and T1. Overall, the total amount of feeds consumed for the 110 days trial showed that T3 was the least consumed followed by T4 while T2 and T1 are comparable to each other. This would indicate that the addition of Pili pulp as supplements at 5% did not reduce the palatability of quail laying mass but increasing the amount to 10% and 15% will significantly decrease feed consumption. This is the first report of the potential palatability of Pili pulp meal as feed supplement for laying quails.

Table1. *Weekly average consumption (kg/cage) of feeds at different sampling period as affected by pili pulp supplement.1*

Treatments	22-Oct	29-Oct	5-Nov	12-Nov	19-Nov	26-Nov	3-Dec	10-Dec	17-Dec	24-Dec	1-Jan	8-Jan	15-Jan	22-Jan	29-Jan	4-Feb	Total
T1	3.566ab	3.506	3.631	3.578ab	3.438a	3.749a	3.673	3.676	3.736a	3.550	2.980	3.085	3.435a	3.315	3.261	1.947	54.125a
T2	3.640a	3.465	3.595	3.664a	3.339ab	3.594ab	3.660	3.680	3.722a	3.541	2.952	3.133	3.488a	3.622	3.337	1.930	54.361a
T3	3.386b	3.357	3.582	3.412b	3.247c	3.442b	3.611	3.596	3.548b	3.432	2.873	2.831	3.010b	3.314	2.974	1.810	51.426b
T4	3.458ab	3.380	3.553	3.490ab	3.327bc	3.443b	3.659	3.624	3.620b	3.535	3.002	2.989	3.259ab	3.323	3.199	1.837	52.698ab
P-value	0.018	0.174	0.074	0.044	0.002	0.004	0.868	0.317	0.002	0.060	0.242	0.089	0.031	0.243	0.117	0.088	0.011

[1]*Means within the same date of sampling, followed by the same letter(s) are not significantly different from each*

Laying Performance of Quails

Quail layers feed to different amount of Pili pulp meal supplement on top of the commercial laying mass has resulted to significant variations in the number of layed eggs per day as expressed in weekly average, the total number of layed eggs for period of 110 days, the cumulative eggs during the 110 days period, and the overall laying percentage. Quail layers feed with 85% laying mass + 15% Pili pulp are the one that layed eggs earlier by 3 to 5 days (T4-October 16, 2017) compared to other treatments (T1-Octpber 20, 2017, T2-October 19, 2018 and T3-October 21, 2017) (data not shown). This would indicate that quails Supplemented with 15% Pili pulp meal attained early sexual maturity. Cumulative numbers of eggs were consistently higher in T4 compared to other treatments (Fig. 1) and consequently T4 had the highest number of layed eggs after 110 days of feeding trial (Fig. 2). The total number of eggs in T4 is 12.7% higher thanT3 which has the lowest number of eggs. The total number of eggs from T1 was significantly higher than T2 and T3 but lower than T4. The laying percentage presented in Figure 3 showed significant differences where quails feed with 15% Pili pulp meal was higher among all the treatments amounting to 84% layed eggs for the duration of 100 days from October 21, 2017 to February 2, 2018. However, those treatments with 5% and 10% pili pulp meal had lower laying percentage than the pure laying mass. It appeared that the incorporation of pili pulp on laying mass improve the laying performance of quails but its favorable effect is only observed at 15% but not on 5% and 10% rate of supplementation. This effect could indicate that at 15% supplement, pili pulp meal had substantially modified the composition of the laying mass and trigger changes on the observed lying performance. These changes could be brought about by the high energy content of pili pulp coupled with the presence of several essential nutrients and antioxidant that would be helpful in relieving stress associated with laying and egg production. As indicated by previous studies, dried pili pulp contain 8% protein, 33.6% ether extract,3.4% crude fiber, 9.2% ash and 45.8% carbohydrate with an energy value of 533 Cal. per 100 g (Maranon et al. 1954, Coronel, R.E., 1996). Therefore the addition 15% of pili pulp would enhance the energy value of the laying mass that would surely satisfy required 260 kJ metabolizable energy/bird-day to maintain a production of 8.3 g egg/bird-day (Yamane et al. 1980) . Similarly, studies of Odunsi, et al. (2007)showed that inclusion of high energy and protein feed components that could supply 21.95% protein requirements for laying quails is beneficial to improve laying performance. These results suggest that Pili pulp meal is a potential supplement for quail layers.

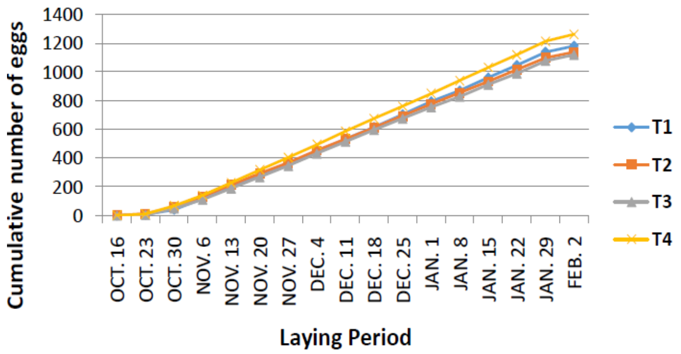

Figure1. *Cumulative number of quail eggs layed at weekly interval as affected by different treatments.*

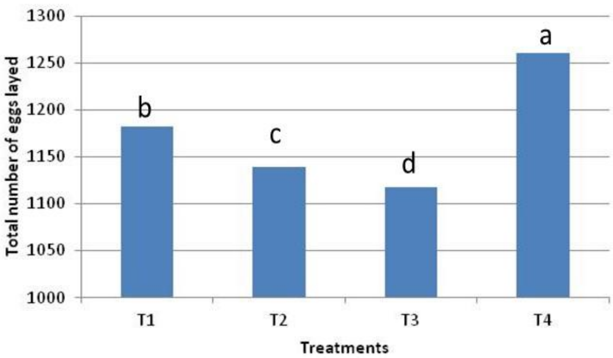

Figure2. *Total number of eggs laid by quails for 110 days feed with commercial laying mass supplemented with Pili pulp meal.*

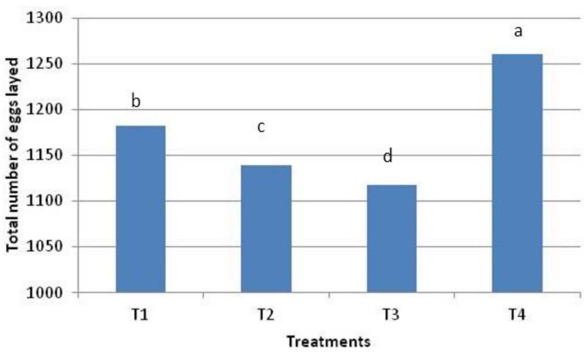

Figure3. *Laying percentage of quails for 110 days feed with commercial laying mass supplemented with Pili pulp meal.*

Physiological Properties of Quail Eggs

The average weight of individual egg on weekly basis was presented in Table 2. Overall weight of individual eggs was significantly affected by pili pulp meal supplement ($p<0.000$). Eggs laid by quails supplied with 5%, 10% and 15% was heavier than those eggs layed by quails feed with pure commercial laying mass. The increased are 6.3%, 5.4%, and 8.2% for T2, T3 and T4, respectively based on the control (T1). During the different sampling period, significant differences was observed during the early laying period and towards the later sampling. However, throughout the whole 110 days laying period, eggs produced from T4 is consistently heavier compared to other treatments. Similar to the total weight of eggs, the weight of egg yolks (Table 3) and egg whites (Table 4) were significantly increased by the incorporation of pili pulp as supplement to laying mass. The mass of the egg yolk in pili pulp supplemented diets were generally increased by 5.3% to 7.9% based on eggs produced by quails feed with pure commercial laying mass. Similarly, the mass of egg white was increased by up to 9.8% based on the control. Both the mass of egg yolk and egg white did not vary significantly in most of the sampling period but the values obtain are numerically

Table2. *Mean weight(g) of quail eggs at different sampling period as affected by pili pulp supplement.1*

	2017										2018				
TRMT	10/28	11/ 4	11/ 11	11/18	11/ 25	12/ 2	12/ 9	12/ 16	12/ 23	12/ 30	1/ 6	1/ 13	1/ 20	1/ 27	overall
T1	11.0	10.7b	10.6b	10.6b	10.9	11.3	11.1	11.0	11.3	11.0b	10.7b	11.4	11.3b	11.3b	11.0b
T2	10.8	11.3ab	11.7ab	11.1ab	11.7	12.0	11.6	11.3	11.8	12.2a	11.8ab	12.1	12.4a	11.9ab	11.7a
T3	10.2	11.6a	11.3ab	11.6ab	11.0	12.6	12.0	11.1	11.2	12.0ab	11.3ab	12.2	12.3a	12.2a	11.6a
T4	11.1	11.6a	11.8a	11.7a	11.3	12.4	12.6	11.8	11.6	11.7ab	12.0a	12.3	12.3a	12.4a	11.9a
Pvalue	0.452	0.026	0.029	0.028	0.253	0.175	0.361	0.158	0.565	0.027	0.024	0.081	0.012	0.009	0.000

[1]Means within the same date of sampling, followed by the same letter(s) are not significantly different from each other based on Tukey's Test at 5% level of significance.

Table3. *Mean weight (g) of the yolk of quail egg at different sampling period as affected by pili pulp supplement.1*

	2017										2018	Overall
TRMT	10/28	11/ 4	11/ 11	11/18	11/ 25	12/ 2	12/ 9	12/ 16	12/ 23	12/ 30	1/ 6	
T1	4.2	3.8	3.7	4.4	4.2	3.3	3.8	3.7	4.6	3.2b	3.4b	3.8b
T2	4.2	4.1	3.7	4.3	4.6	3.7	3.8	4.0	4.6	4.0a	3.7ab	4.1a
T3	4.0	4.3	4.1	4.3	4.6	3.9	4.0	3.6	4.9	4.0a	3.8ab	4.1a
T4	3.8	4.0	4.1	3.9	4.8	3.7	3.4	3.8	4.6	3.9a	4.0a	4.0a
P-value	0.457	0.163	0.325	0.592	0.418	0.336	0.204	0.462	0.563	0.007	0.044	0.054

[1]Means within the same date of sampling, followed by the same letter(s) are not significantly different from each other based on Tukey's Test at 5% level of significance.

Table4. *Weight of quail egg whites (g) at different sampling period as affected by pili pulp supplement.1*

	2017										2018			
TRMT	10/28	11/ 4	11/ 11	11/18	11/ 25	12/ 2	12/ 9	12/ 16	12/ 23	12/ 30	1/ 6	1/ 13	1/ 20	Overall
T1	4.6	4.2	4.1	4.7	5.0	5.3	5.7	6.1	5.3b	4.9	5.3b	5.6	5.6	5.1b
T2	4.4	4.2	4.4	5.1	5.0	5.6	5.7	6.1	6.1ab	5.9	5.8ab	6.6	5.8	5.4a
T3	4.8	4.3	4.1	5.6	4.6	5.9	5.7	5.9	5.7ab	5.6	6.4a	6.4	6.0	5.5a
T4	4.3	5.0	4.6	5.2	5.2	5.7	6.4	5.6	6.2a	5.7	6.3a	6.4	5.9	5.6a
P-value	0.673	0.090	0.685	0.153	0.348	0.397	0.167	0.384	0.031	0.064	0.046	0.188	0.555	0.000

[1]Means within the same date of sampling, followed by the same letter(s) are not significantly different from each other based on Tukey's Test at 5% level of significance.

Higher compared to the control. The increase of weight of eggs associated with the pili pulp supplement could be attributed to the presence of tocophenol content of Pili pulp. Studies of Ri et al, (2015) showed that the egg weight (P=0.01), egg specific gravity (P=0.01), egg shell thickness (P=0.05) and Haugh unit (P=0.01) were positively influenced by vitamin E supplementation even under heat stress. Aside from that, increase in protein levels would also increase the weight of eggs. Similarly, the high antioxidant contents of pili pulp would enhance the quality by enhancing yolk retinol levels, and β-Carotene contents (Jiang et al. 1994).

The color of egg yolk was not significantly affected by the incorporation of pili pulp to diets of quail layers except during the December 9. 2017 sampling (Table 5). Although pili pulp contains xanthophylls pigment, drying process might have resulted to degradation of the pigment. In the study of Chen et al. (2007), they have concluded that drying resulted in a complete and partial degradation of xanthophylls and all-trans-β-carotene, respectively in mango fruits. It is likely that similar degradation of pigment of Pili pulp occurred during the drying process thereby not resulting to expressed effect on the color of egg yolks. Unlike the result of Orejudos (2017), moringa meal supplement enhanced the color development of egg yolk which attributed to the carotenoids pigments in the leaves of moringa.

Overall, the use of dried pili pulp meal as supplement for laying quails at the rate of 15% showed great potential in improving the laying performance of quail layers and increasing the size of eggs while lowering feed consumption. However, for future study, drying process of pili pulp should be improve to preserve and reduce the degradation of pigments so that it will improve the egg yolk color.

Table5. *Mean colour score of quail egg yolks at different sampling period as affected by pili pulp supplement.1*

	2017										2018				
TRMT	10/28	11/ 4	11/ 11	11/18	11/ 25	12/ 2	12/ 9	12/ 16	12/ 23	12/ 30	1/ 6	1/ 13	1/ 20	1/ 27	Overall
T1	9.2	7.3b	8.9	7.1	7.7	9.4	9.8a	5.1	6.8	6.7	6.2	7.3	6.1	7.0	7.5
T2	9.0	8.4ab	8.8	6.6	7.1	9.2	8.9ab	6.2	7.6	7.0	5.1	7.9	6.3	7.3	7.5
T3	8.4	8.6ab	9.8	6.1	6.3	8.7	8.0ab	6.6	6.6	6.1	5.1	6.4	4.6	6.4	7.0
T4	7.9	9.7a	9.2	7.7	6.7	8.9	7.1b	7.7	8.0	7.3	6.3	7.1	6.1	6.6	7.6
P-value	0.639	0.002	0.445	0.359	0.576	0.675	0.000	0.096	0.077	0.282	0.293	0.435	0.067	0.456	0.112

[1]*Means within the same date of sampling, followed by the same letter(s) are not significantly different from each other based on Tukey's Test at 5% level of significance*.

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