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THE EFFECT OF PUMPKIN PEELS (*Cucurbita maxima*) ON THE QUALITY OF JAPANESE QUAIL FLESH

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ABSTRACT

The use and benefit of Pumpkin (*Cucurbita maxima*) peel is still not prominent and acknowledged by many people till now. The peel which is reported to be abundant with beta-carotene are not palatable and commonly discarded. The main objective of this experiment is to determine the effect of different concentrations of pumpkin peel powder (PPP) as feed formulation on the flesh quality of Japanese quail (*Coturnix japonica*). The following treatments were applied; commercial feed with 0% PPP (Treatment 1; T1), 2% (Treatment 2; T2); 4% (Treatment 3; T3) and 6% (Treatment 4; T4) for 3 weeks after fully fed with commercial feed for 2 weeks. The main analytical tests conducted were feed analysis, carotenoid content, drip loss, colour and texture. Carotenoid content was analysed by using spectrophotometer. The results obtain indicated that the highest concentration (6%) of pumpkin peel powder showed the highest reading of carotenoid content ($p<0.05$) while treatment 2 with 2% of PPP obtain the highest weight gain ($p<0.05$). In conclusion, this study showed that quail feed which supplemented with higher PPP may help in producing quail flesh with antioxidant properties.

Key words: Pumpkin peel powder, antioxidant, carotenoid, postharvest quality

INTRODUCTION

Pumpkin (*Cucurbita maxima*) was reported to have abundant amounts of carotenoids (Lucia *et al*., 2014). Surprisingly, pumpkin seeds and peels are normally discarded as an agro-waste but are reported to have higher nutrients as compared to the pulp (Kim *et al*., 2012; Singh *et al*., 2016). Peels of *C. maxima* was reported to have the highest tocopherol and carotenoids (Azevedo-Meleiro & Rodriguez-Amaya, 2007; Kandlakunta *et al*., 2008; Kurz *et al*., 2008). However, the unpalatable characteristic of pumpkin waste limits its edible usage. Therefore, the waste of *C. maxima* peel has a potential to be made as feed formulation for livestock and poultry (Zhou *et al*., 2007; Kim *et al*., 2012; Singh *et al*., 2016; Sathiya & Anjali, 2016; Ana *et al*., 2016) and subsequently beneficial to humans.

Feeding has been recognized as an important aspect as it accounts for 70-75% of the total cost involved in quail production (Panda & Mohapatra, 1989). Higher price of feeds reported by Rahman *et al*. (2016) could be a financial problem for the farmer in quail rearing business. Solving the problem by reducing the cost of production could be done by incorporating cheaper and non-conventional sources into the ration. In addition, antioxidants that are included in the feed may reduce the spoilage of meat during storage. Pumpkin peel which was reported to be high in α-tocopherol is easily converted into vitamin E (Kim *et al*., 2012). Thus, the dietary addition of vitamin E in feed results in higher meat oxidative stability (Winnie & Dirink, 1996; Grau *et al*., 2001) and improvement of the nutritive value of the meat. Hence, the objective of this study is to evaluate the effect of pumpkin peels on the flesh quality of Japanese quail.

MATERIALS AND METHODS

Experimental animals

A total of 24 Japanese quails (*Coturnix japonica*), one week old in age were used in this study. Water supply was provided ad-libitum and replaced daily to prevent any infection. The cage was supplied with proper ventilation and light. Cleansed pumpkins at index 5 and 6 were peeled

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off and the peels were dried at 55°C for 14 hours. Peel samples were ground into powder and kept in a dry place (Sheikhzadeh *et al*., 2016).

Feeding method

Each quail was fed daily with different concentrations of pumpkin peel incorporated with commercial feed. All quails were fed with commercial diet feed as control (Treatment 1; T1), and mixed with different concentrations of pumpkin peels which were 2% (Treatment 2; T2), 4% (Treatment 3; T3) and 6% (Treatment 4; T4), respectively. Quails were fed with commercial starter feed for the first two weeks and followed by treatment feeds from week three to week six. Quails were sustained for 16 hours of light and 8 hours of dark photoperiod to enhance eating period and prevent injury.

Feed analysis

Standard solution was prepared by dissolving 25mg of β-carotene into ethanol (1:1) to give a concentration of 1mg/mL of the mother liquor. The solution was heated in a water bath until 40°C and appropriately diluted with phosphate buffer solution solvent. The sample was then analysed at 450 nm of wavelength using spectrophotometer and the absorbance was calculated by using β-carotene as the standard.

Weight gain analysis

All quails were weighed individually on portable balance every week. The final weight was then compared with the initial weight.

Texture and firmness of quail

The firmness of the quail flesh was determined weekly by using texture analyzer with probe P5.

Colour analysis

The colour of the breast meat was measured after 24 hours post slaughter using Conica Minolta chromameter with values a* and b*. The a* value indicate redness and b* value for yellowness. Both values are important to relate the contribution of yellowness from pumpkin peel powder into feed and flesh.

Determination of carotenoid content

An amount of 2g of peel was homogenized with 1g of ascorbic acid. Samples then were mixed with 20mL alcoholic potassium hydroxide (KOH) and placed in water bath for 30 minutes at 80°C. Samples were centrifuged for 10 minutes at 200 rpm. The sample was extracted with 5mL of acetone in a separatory funnel. The extraction was then transferred into another separatory funnel containing 15mL hexane. The collected solution (upper layer) was placed into volumetric flask and adjusted into 20mL with hexane. Absorbance was measured using spectrophotometer at 450nm with acetone as calibration and compared with β-carotene as the standard.

Drip loss analysis

Drip loss test was done to determine the spoilage of quail meat on the first day of experiment as well as on the fourth day after storage. An amount of 1 g of meat was dabbed with Whatmann filter paper no 1 and put into centrifuge tube. Samples were centrifuged at 1000 xg for 10 minutes and the weight was recorded. The calculation of drip loss was calculated according to Kim *et al*. (2016).

$$\textit{Drip loss}\ (\%) = \frac{\textit{Weight before centrifugation (g)} - \textit{Weight after centrifugation (g)}}{\textit{Weight before}\ \text{centrifugation (g)}} \times 100$$

Statistical analysis

Data was subjected to the statistical One-Way Analysis of Variance (One Way ANOVA) as well as Friedman and Kruskal Wallis test and the difference was estimated at $p<0.05$.

RESULTS AND DISCUSSION

Carotenoid content in different concentrations of feed

Results indicated the effects of different concentrations of pumpkin peel powder (PPP) towards the beta-carotene content. There was no significant difference among treatments in the present study for β-carotene content in each treatment applied (Figure 1). The similarities between treatments may probably vary due to the diet processing methods where carotenoid destruction occurred as carotenoids are prone to the loss of carotenoid activity through oxidation during processing (Dutta *et al*., 2005). The oxidation may be minimized by freshly preparing the feed prior

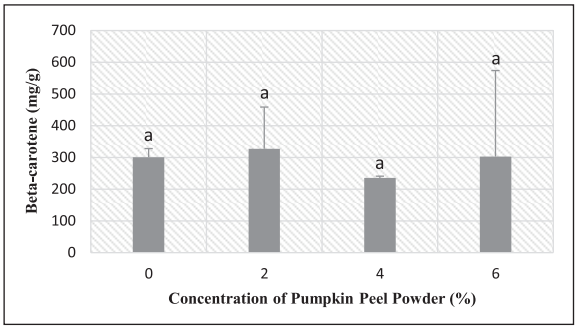

Fig. 1. Carotenoids content of different concentrations of pumpkin peel powder (PPP) by using β-carotene as standard curve.

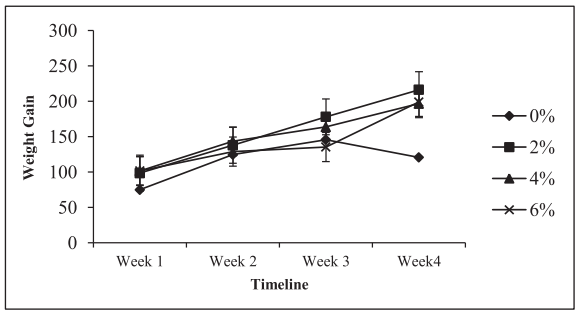

Fig. 2. Weight gain of Japanese quail meat fed with different concentrations of pumpkin peel powder (PPP).

to feeding. Storage of the feed at low temperature (4°C) under dark conditions is better to stabilize the carotenoids (Saini *et al*., 2016; Lin & Chen, 2005).

Effect of pumpkin peel on the weight gain of Japanese quail

Figure 2 shows the effect of different concentrations of pumpkin peel powder incorporated with commercial feed on weight gain of Japanese quail. Results showed different weight gain of quail treated with different concentrations. Surprisingly, treated quail especially T2 (2% PPP) showed highest weight gain ($p<0.05$) while control treatment (T1=0% PPP) showed decline in weight at week 4. Similar results was also observed by Sahin *et al*. (2008) which reports about the significant weight gain in quail supplemented with lycopene.

The reduction of weight in untreated quail was probably due to the stress where physiological activities of the control quails were unbalanced. The cage was fully covered with mulching net with no light bulb. Although other treatment groups of quails were placed in the same environment, they have been fed with pumpkin peel powder which known to have antioxidants. Studies have shown that diets enriched with antioxidants could be used to reduce the negative effects of environmental stress, which implies that detrimental effects of environmental stress could partly be responsible in induction of oxidative stress (Bollengier-Lee *et al*., 1998; Sahin & Kucuk, 2003). Pumpkin peel probably exhibits an antioxidant effect by removing free radicals from the environment (Tanaka *et al*., 1997) while the active radicals break chains, exert pressure, renovate, and increase endogen defence (Azzi & Stocker, 2000). Antioxidants by the pumpkin peel were capable to neutralise the negative effect of heat stress and positively affected the growth performance. The results revealed that lower concentration of PPP (2%) obtain significantly higher weight gain compared to the higher concentrations. This can be explained with a study by Jorgensen and Skibsted (1993) which found that carotenoids may work as pro-oxidants at high supplementation levels and as antioxidants at low levels.

Effect of pumpkin peel on the breast weight gain of Japanese quail

However, the positive effect of pumpkin peel was not effective on the breast weight. Figure 3A revealed the condition of similar weight for all treatments; T1 (0% PPP), T2 (2% PPP), T3 (4% PPP) and T4 (6% PPP) were 30.48g, 53.60g, 50.50g and 43.27g, respectively. The results probably were due to environmental stress faced by the quails as the cage or rearing site was fully covered and may have proven uncomfortable conditions for the quail. Besides, the main function of antioxidants is not to increase weight or growth promoter. The similar negative effect was also found by Ri *et al.* (2017) and Imik *et al.* (2005) when they supplemented avians with antioxidants. No growth increment was detected except reduction of lipid oxidation in the meat (Imik *et al.*, 2005).

Effect of pumpkin peel on the texture and firmness weight gain of Japanese quail

In this study, there was no significant difference among treatments on texture of quail meat (Figure 3B). T1 (0% PPP), T2 (2% PPP), T3 (4% PPP) and T4 (6% PPP) obtain almost the same average value of firmness. This no effect of pumpkin peel towards the meat texture was probably due to the insufficient antioxidants on minimizing the oxidation of protein to retain the texture of meat (Gallo *et al*., 2012). Shizadegan and Falahpour (2014) revealed that more than 8% antioxidants in feed is required to increase the antioxidative activity of meat and subsequently affect the properties of meat.

Effect of pumpkin peel on the flesh colour of Japanese quail

Figure 3C and Figure 3D showed there was no significant difference for a* and b* values among treatments ($p>0.05$), respectively. All groups were found to be similar in redness and yellowness of meat.

The treatments applied did not influence the redness of the flesh. The a* values could be roughly divided as low – 9.7 (Oguz *et al*., 2004; Gevrecki *et al*., 2009), medium – 11.7–12.5 (Tarasewicz *et al*., 2007) and high – 13.1–16 (Imik *et al*., 2010; Wilkanowska & Kokozynski, 2011). Thus, the a* values of T2 (2% PPP) and T3 (4% PPP) in this study were considered at a medium level with 11.2 and 12.1 respectively. T1 (0% PPP) and T4 (6% PPP) may be linked to a condition of decreasing mineral availability in muscle tissue (Mancini & Hunt, 2005). Natural antioxidants can attenuate these effects (Anosa & Okoro, 2011). Study by Imik *et al*.

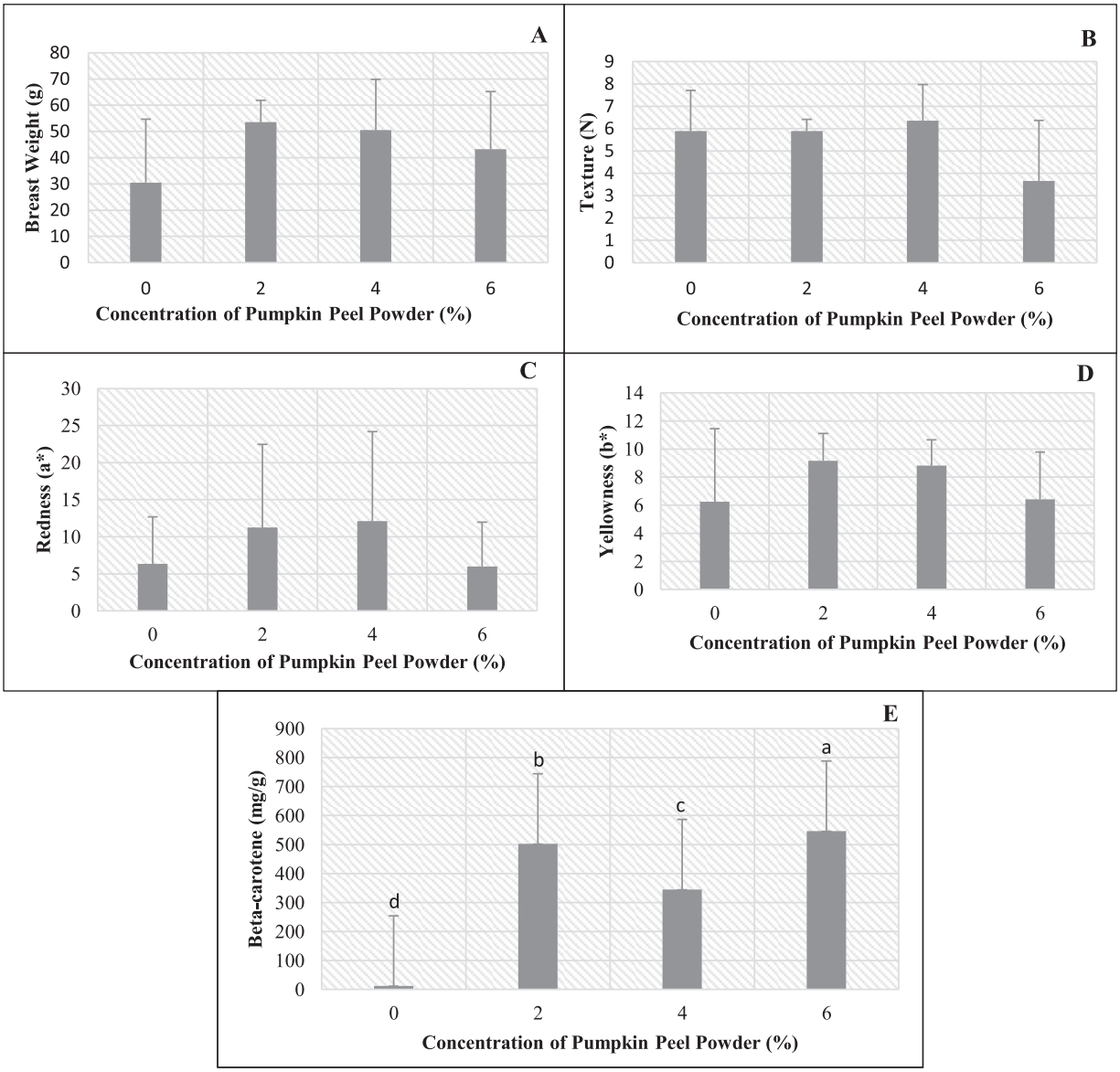

Fig. 3. Effect of different concentrations of pumpkin peel powder (PPP) on parameters; A. Breast weight (g); B. Texture (N); C. Redness (a*); D. Yellowness (b*); E. β-carotene (mg/g), of Japanese quail.

(2010) make it clear that antioxidants affect colour parameters of the meat to a different extent, nonetheless not proven in the present study. The antioxidant source used by Imik *et al.* (2010) were synthetic sources which definitely have higher capability (Pokorný, 2007) to give the significant effect to the meat compared to the natural source used in this study.

The addition of pumpkin peel powder (PPP) proved to not influence the yellowness of the meat. Similarly, studies by Karadas *et al*. (2015) reported no differences were found between the breast and leg skin in terms of meat yellowness (b*) of the control and treated meat with β-carotene. Bianchi *et al.* (2005) reported yellowness (b*) values of 6.2 for normal breast meat and 7.6 for pale breast meat and the value is close to T1 and T4 for this study. Meanwhile, T2 and T3 are very close to those reported in previous studies by Castroman *et al.* (2013), Inborr and Lignell (1997) and Waldenstedt *et al*. (2003).

Effect of pumpkin peel on the carotenoid content of Japanese quail flesh

In this experiment, T4 (6% PPP) show significantly highest β-carotene content ($p<0.05$) compared to T1 (0% PPP). Antioxidants content of the quail is expected to increase with the increasing of the concentration of pumpkin peel in their feed formulation (Figure 3E). However, T3 (4% PPP) showed less β-carotene content compared to T2 (4% PPP) due to extremely low concentration

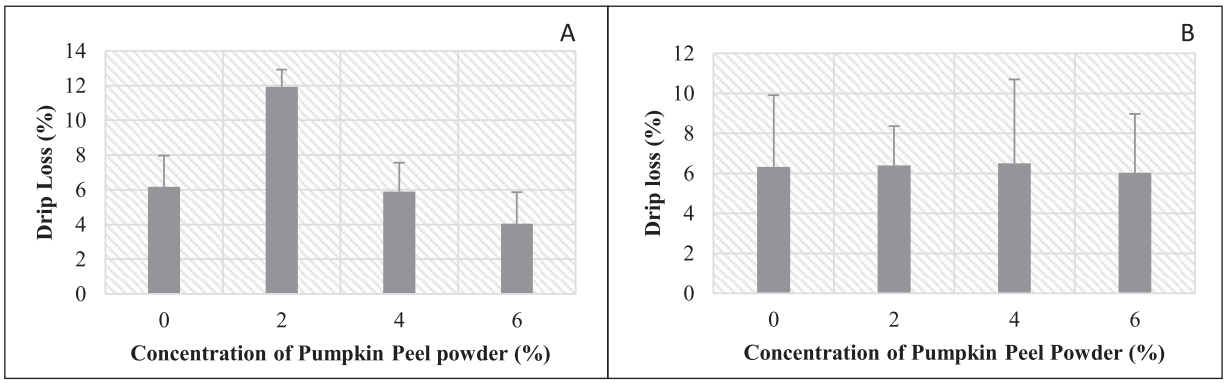

Fig. 4. Drip Loss of Japanese quail meat after 24 hours of post-slaughter (A) and after storage at 2°C for 4 days (B).

(Botsouglou *et al.*, 2004; Shizadegan & Falahpour, 2014).

Similar result was presented by Sahin *et al*. (2008) who proved 5% of tomato powder supplementation diet increased antioxidant concentration in poultry muscles. Moreover, Botsoglou *et al*. (2004) was also reported 5% of dried tomato pulp showed antioxidative properties when incorporated in quail diet. Similarly, these studies applied almost the same percentage of β-carotene with the present study (T4-6%) and resulted in providing antioxidant properties which enhance the quality of meat sample.

Meat and meat products are poor in vitamin A (Daniela *et al*., 2014). Thus, this result proves that PPP has an influence in increasing β-carotene content in meat. This probably results in producing higher quality of meat where the antioxidative properties influence in delaying the oxidative process resulting in extending the shelf life of the meat (Shahid & Zhong, 2010; Labaque *et al*., 2013).

Effect of pumpkin peel on the drip loss of Japanese quail flesh

Figure 4A and 4B showed the drip loss of meat before and after storage. There was no significant difference of drip loss among treatments before and after storage ($p>0.05$) resulting in no impact of the treatments applied towards retaining the postharvest quality of meat.

Different concentrations of pumpkin peel powder (PPP) in the feed indicate almost the same percentage of drip loss in meat. Drip loss was closely related with water holding capacity and protein oxidation (Lonergan *et al*., 2001). Thus, this study showed supplemented antioxidant towards the animal could not affect the protein oxidation during storage.

In conclusion, results of this study indicated that pumpkin peel powder (PPP) showed antioxidative properties when incorporated in quail diet at the level of 2% and 6%, respectively. Treatments with 2% influenced the pre-harvest quality in terms of live weight gain and treatment with 6% PPP obtain the highest value of carotenoid content in flesh. Carotenoids may work as pro-oxidants at high supplementation levels and as antioxidants at low levels. Feed with 4% was not an optimum concentration to get the beneficial effect. Incorporation of PPP at the level of 6% exerted a pro-oxidant effect and there might be an interaction between PPP and R-tocopherol which is important for the balance between pro- and antioxidative activities. In contrast, 2% PPP influenced the quality of the animal. Future studies should be focused on the interaction between individual carotenoids and tocopherol in order to better elucidate their role in oxidative changes. The sample size should also be increased to see the better implication and representation. Moreover, incorporation of commercial feed and treatment should homogenize properly or the feed may inject directly into the animal for the efficacy of feed consumption.

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