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Kinetics of Tannin Reduction in Soaked and Unsoaked Velvet Beans Treated by Microwave Treatment

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Abstract

The effect of microwave treatment on the kinetics of tannin reduction in black and white colored velvet bean (soaked and unsoaked) was evaluated. The objective of this study was to determine the association level and the kinetics of tannin reduction in velvet beans after being treated with microwave treatment in order to find the appropriate time treatment useful for poultry health. Tannin content reduction rate was nicely fitted by linear regression analysis with association value (r) ranging from 0.96-0.98. Linear regression analysis suggests a zero-ordered kinetics which means that the decline rate of tannins after exposure to microwave treatment is independent of the initial tannin concentration. In both colored velvet bean (black and white), the tannin reduction rate of unsoaked seeds was lower than that of soaked seeds. According to literature findings regarding the positive role of tannins level in poultry, it can be concluded from this study that the exposure of velvet bean to microwave treatment for more than 12 minutes may eliminate the positive effect of tannin on poultry.

Keywords: *Velvet Beans, Microwave Treatment, Kinetics of Tannin*

1. Introduction

Velvet bean seed is considered as an important feed source that can be milled and incorporated to both monogastric and ruminant's diets (Chikagwa-Malunga et al., 2009; Eilittä et al., 2003). Although velvet bean seed high levels of proteins, it can be fed to ruminants but in low levels in poultry diets (Chikagwa-Malunga et al., 2009). The presence of antinutritional factors limits their inclusion in poultry diets. For example, feeding a broiler a raw velvet bean at a level of 5% has been reported to cause a 25% reduction in animal performance (Iyayi et al., 2006), unless suitable processing treatments are implemented to minimize the influence of antinutritional presence (Carew et al., 2006). Many antinutritional factors have been reported to be present in velvet beans such as phytate) and trypsin inhibitors (Pugalenthi et al., 2005, antitryptic factors, L-dopa, tannins and hemagglutination factors (Vadivel et al., 2011). From a processing perspective, soaking alone in water has been reported not to be efficient (Nyirenda et al., 2003; Vadivel et al., 2011), therefore, thermal treatment is necessary to minimize the influence of these antinutritional factors (Tuleun et al., 2008). Both soaking and thermal treatment of velvet beans have been reported to reduce the level of tannins (Kala and Mohan, 2012). However, among these antinutritional factors, tannins have been shown to be beneficial to animal health and growth when present in animal feed at certain levels (Tonda et al.,

2018; Cengiz et al., 2017). In their review, Choi and Woo (2020) reported that high levels of tannins have a negative influence when fed to poultry and that predetermined suitable levels of tannins in poultry feed are essential for their usage as a practical alternative solution for the challenges found in poultry industry such as using antibiotics.

Reduction in tannin content in velvet beans by microwave treatment has been shown to depend on exposure time (Kala and Mohan, 2012). However, the association level and the rate of tannins reduction in velvet beans after being treated with microwave treatment (with or without soaking) were not estimated. The main objective of this study was to identify the association level and the rate of tannin reduction after the exposure of velvet bean (with or without soaking) to microwave treatment. This has an important relevance to poultry health by determining the appropriate tannin content beneficial to poultry nutrition after thermal treatment (i.e., microwave treatment).

2. Materials And Methods

Treatments

Sample collection of velvet bean seeds, soaking with water treatment, microwave processing procedure, and tannins chemical analysis were obtained and described in detail from the previous experiment reported by Kala and Mohan (2012). Briefly velvet beans (in raw and soaked forms) were placed in Petri dishes and exposed to microwave treatment for six processing time intervals (0, 2, 4, 8, 10, and 12 minutes). After seed processing by microwave treatment, seeds were milled and analyzed for tannin level.

Data Fitting

The effect of microwave treatment on tannin level on velvet bean was adapted from the previous work of Kala and Mohan (2012) (Table 1). Linear regression analysis was applied to estimate the reduction rate in tannin level after being exposed to microwave treatment at different intervals. The model will take the form of y= b0+ where b0 is the y-intercept, b1 is the slope (i.e. rate of tannin reduction), and x is the predictor variable (i.e. microwave exposure time. A simple linear regression analysis was performed using Excel sheet (Microsoft, 2010). Strength if linearity in regression analysis (indicated by association value (r)) will provide a measure of the applicability of zero-order kinetics. Presence of zero–order kinetics indicate the rate reduction in tannin is independent of the initial tannin level.

3. Results and Discussion

The results of this study showed that the effect of microwave treatment on tannins levels in velvet beans (i.e., white and black colored velvet beans) is well fitted with simple linear regression analysis. The slope of the regression line indicates the rate of reduction of tannins concentration over the exposure time to microwave treatment. In the case of white-colored velvet beans, exposure of soaked white beans to microwave treatment increased the reduction rate of tannin concentration almost by double compared to unsoaked beans (0.0084 and 0.0046 g/min, respectively) as shown in Figure 1 and Figure 2, respectively. A similar influence was found in the case of black-colored velvet beans. The exposure of soaked black velvet beans to microwave treatment increased the reduction rate of tannin concentration in unsoaked beans (0.0113 and 0.0059 g/min, respectively) as shown in Figure 3 and Figure 4, respectively. Tannins are considered as polyphenolic compounds that have the capability to precipitate proteins (Redondo et al., 2014). Presence of tannins in monogastric animals can negatively influence animal performance by decreasing feed intake and nutrient digestibility (Garcia et al., 2004). Tannins can bind to protein and thus weaken protein digestion and inhibit the activity of digestive enzymes (Medugu et al., 2012). The reduction in feed intake in monogastric animals has been attributed to that tannins can bind to proline-rich protein compounds that are responsible for a sharp taste and consequently reduce feed palatability (Butler et al., 1984). However, tannin may possess a positive effect on poultry performance by enhancing the immunity system against bacterial disease (Tonda et al., 2018), reducing foot pad dermatitis (Cengiz et al., 2017) , and reducing lipid oxidation (Starˇcevi´c et al., 1984). Recently, tannins gained attention as capable bioactive compounds as a potential alternative for growth promoters in the poultry industry (Choi and Woo, 2020). Tannins and their derivatives compounds showed bacteriostatic and bactericidal effects on many infectious diseases such as Staphylococcus aureus (Maisetta et al., 2019) Salmonella Typhimurium (Reyes et al., 2017), Escherichia coli (Daing et al., 2017), S. enteritis Enterococcus (Daing et al., 2017), Clostridium perfringens (Elizondo et al., 2010).

Determining the appropriate level of tannins is critical for their potential implementation as a solution for the challenges faced in poultry production (Choi and Kim 2020). The positive or the negative effect of tannins on monogastric animal diet seems to be dosage depended. Tannins concentration range from 0.5 g/kg to 5 g/kg in poultry diets has been reported to enhance poultry growth performance and enhance overall all poultry health status (Choi and Woo, 2020). However, the negative influence of tannins is shown when tannins concentration in the diet exceeded 7.5 g/kg (Kubena et al.,2001). A tannin concentration above 25 g/kg has been reported to show toxic effects in poultry through enhancing liver proteolytic activity (Marzo et al., 2002). In this study, the initial concentration of tannins in raw white and black-colored velvet bean is low (tannin levels 1.4 and 1.8 g/kg, respectively). Thus, exposure of both accessions of velvet bean to microwave treatment for more than 12 minutes can eliminate the positive effect of tannin on poultry growth and performance. However, such processing time may be not enough to deactivate the presence of other antinutritional factors present in velvet beans (Kala and Mohan, 2012). Therefore, in vivo, experiments on poultry should be conducted to examine the influence of microwave treatment time on velvet beans (with or without soaking) without overlooking the negative influence of other antinutritional values present in velvet beans.

Table 1. Effect of different microwave exposure time on tannins level (g/100 g) in Velvet beans (White colored seed coat and Black colored seed coat) (adapted from Kala and Mohan (2012).

Time duration (min)	Accessions			
	White colored seed coat		black colored seed coat	
	No soaking	With soaking	No soaking	With soaking
0	0.14	0.14	0.18	0.18
2	0.12	0.11	0.16	0.14
4	0.11	0.11	0.14	0.10
8	0.09	0.09	0.12	0.08
10	0.09	0.05	0.11	0.06
12	0.08	0.03	0.11	0.03

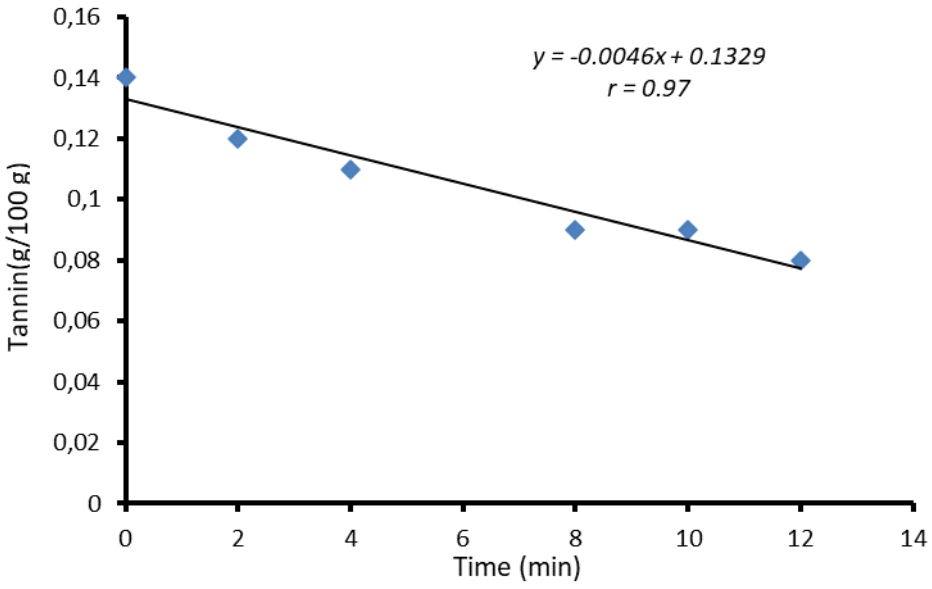

Figure 1. Time dependence of tannins level (g/100g) of raw white colored seed coat velvet bean after microwave treatment.

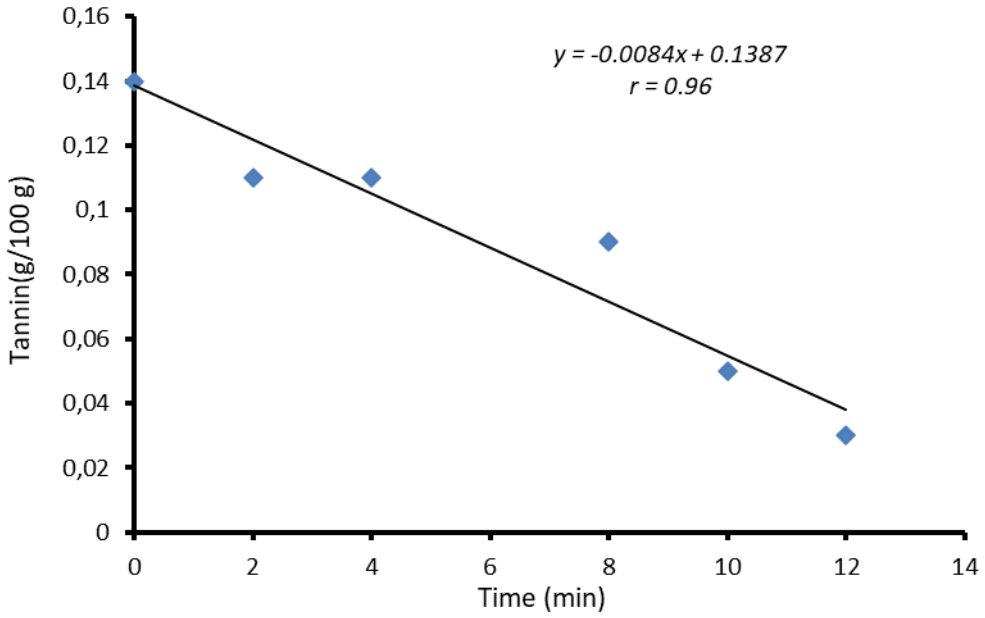

Figure 2. Time dependence of tannins level (g/100g) of soaked white colored seed coat velvet bean after microwave treatment.

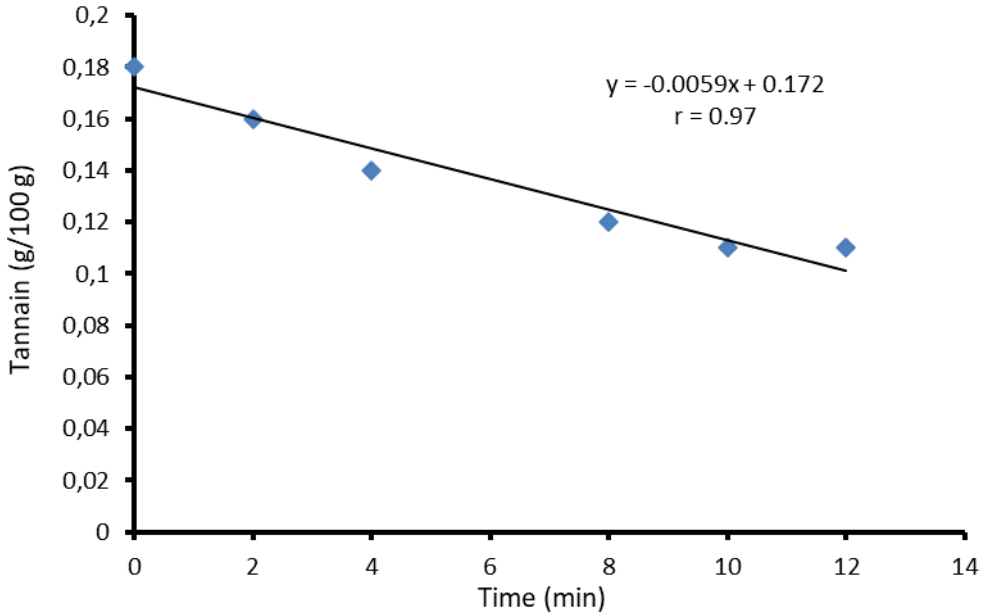

Figure 3. Time dependence of tannins level (g/100g) of raw black colored seed coat velvet bean after microwave treatment

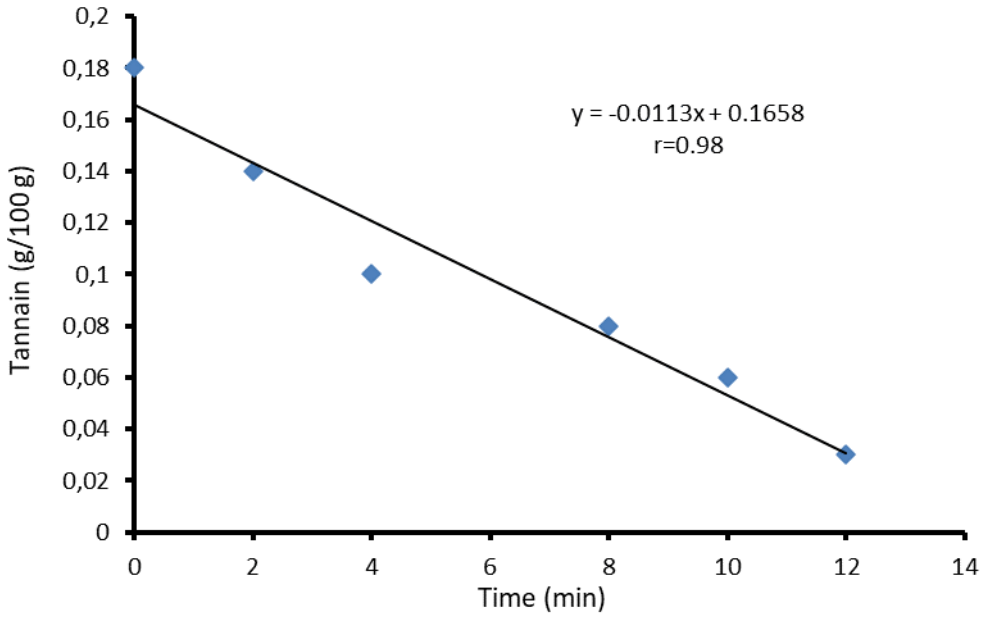

Figure 4. Time dependence of tannins level (g/100g) of soaked black colored seed coat velvet bean after microwave treatment.

4. Conclusion

It can be concluded from this study that the effect of microwave treatment on tannins concentration in both accessions of velvet beans (i.e., white and black colored velvet beans) is well fitted with simple linear regression analysis. The exposure of both accessions of velvet bean to microwave treatment for more than 12 minutes may eliminate the positive effect of tannin on poultry.

Conflict of interest:
The authors declare no conflict of interest.

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