

《Research Note》

Descriptive Sensory Traits of Cooked Eggs Laid from Hens Fed Rice Grain

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Descriptive sensory characteristics of eggs produced by conventional corn-based feeding and unhulled whole rice grain-feeding were compared in two cooking procedures using a trained panel. Rice-feeding significantly decreased brothy and roasted odor in eggs cooked into half-cooked egg yolks, and decreased the creamy odor, smoothness and moisture of eggs cooked into custard puddings. However, a statistical interaction between rice-feeding and production farm was not observed in every sensory attribute. These findings indicated that replacing corn with unhulled whole rice grain in diets for laying hens alters the sensory attributes of eggs.

Key words: descriptive sensory traits, egg, rice grain-feeding

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Introduction

Rice grain has been an important feed source for animal production in Japan. Production of rice grain for animal feed, as a substitute for corn grain, has been encouraged by the Japanese government in accordance with decreasing rice consumption by the Japanese population (United States Department of Agriculture, 2017). Particularly in poultry farming, rice grain is a useful feed source because corn grain in hen and broiler diets can be replaced by whole-grain rice (Sittiya *et al.*, 2011) without the need for grinding (Sittiya and Yamauchi, 2014). Also in laying hens, replacement of corn with rice grain does not decrease laying performance or egg quality, other than yolk color (Waki and Murano, 2009; Sittiya *et al.*, 2014). Utilization of rice grain for animal feed is also beneficial for consumers. For example, Japanese consumers are willing to pay premium prices for eggs labeled as 'rice-fed' (Imai *et al.*, 2012). Such consumer sentiment is useful for marketing and promotion of eggs produced using rice grain feed. However, it is not clear whether eggs produced by rice-fed hens offer real benefits to consumers, in terms of quality, when compared to eggs produced using

conventional corn-based diets.

Generally, the diets of laying hens impact egg quality, in particular, the sensory attributes. For example, supplementation of canola meal and flaxseed oil in poultry feed diets affected flavor characteristics of cooked eggs (Goldberg *et al.*, 2016). Additionally, Hayat *et al.* (2010) and Hwang *et al.* (2014) reported that treatment of hens' diet impacted the flavor of eggs. Dietary treatments have also been shown to have an effect on the quality of eggs and improved consumer eating preference (Loar *et al.*, 2010). Therefore, it is plausible that the sensory attributes of eggs produced through rice-based feed may be beneficial for consumers. In addition, if sensory characteristics such as taste, odor and texture differ between rice-fed and conventional eggs, it would be beneficial to include descriptive labeling highlighting rice-based diet. For promotional marketing of eggs produced through a rice-based diet, these differences in sensory characteristics between rice-fed and conventional eggs, that cannot be detected by instrumental analysis, must be emphasized. For this purpose, this study compared descriptive sensory characteristics between rice-fed and conventional corn-based formula-fed eggs using a trained sensory panel, in two cooking procedures.

Materials and Methods

Egg Samples

Egg samples were obtained from two farms. Detailed feed-

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Table 1. Feeding conditions

	Farm	
	A	B
Hens	Boris Brown	Boris Brown
Control diet	Commercial corn-based formula diet	Corn (67.08%)-based custom diet
Rice diet	Unhulled whole rice grain 30%	Unhulled whole rice grain at 59.74% replacing corn in control diet
Age of hens (days)		
1st trial	214	580
2nd trial	236	599
Period of rice feeding (days)		
1st trial	46	18
2nd trial	68	37

Table 2. Sensory attributes and their definitions used in descriptive sensory sessions

Attributes	Definition
<i>Taste</i>	
Sweet	Sweet taste
Bitter	Bitter taste
Salty	Salty taste
<i>Umami</i>	Umami taste, monosodium glutamate or inosine monophosphate
<i>Koku</i> (body)	Body and/or complexity
Aftertaste	Intensity of taste after swallowing
Mellow	Smallness of stimulation
<i>Odor (Retronasal)</i>	
Creamy	Cream-like or dairy product-like odor
Sweet	Sweet odor, like vanilla or fruit
Brothy	odor like Japanese soup stock
Roasted	Roasted odor
Sulfur	Sulfur, egg-like odor
<i>Texture</i>	
Stickiness	Intensity of stickiness to oral cavity
Fluidity	Degree of flowing like liquid
Springiness	Force and degree of recovery from a deforming
Fineness	Degree of smallness of granularity
Smoothness	Degree of flatness of surface of a sample
Moisture	Amounts of fluids released from a sample
Tenderness	Force required to deform and masticate a sample

ing conditions such as type of feed and feeding period in both farms are presented in Table 1. Samples were collected at two time intervals in each farm; at 46 and 68 days in farm A, and 18 and 37 days in farm B (Table 1) to investigate whether varied rice-feeding conditions resulted in differences in egg sensory characteristics. Age and feeding period did not differ between the control and rice-fed hens within each farm. Egg albumen and yolk were separated, filtered using 2-mm stainless mesh and collected immediately before testing sample preparation.

Sample Preparation

Two cooking procedures were employed for sensory

evaluation, namely half-cooked egg yolks and custard puddings. For half-cooked egg yolks, 8 mL each of egg yolk was dispensed into a polypropylene cup and cooked by steaming using a steam-convection oven SSC-5DCNU (Maruzen, Tokyo) set at 70°C for 20 minutes, to maintain hygiene of the samples. Heat-treated samples were covered with a polyethylene-terephthalate lid and stored in an incubator set at 60°C before sensory sessions. Custard puddings were prepared according to a previous report (Shimosaka *et al.*, 2004), with some modifications. Briefly, egg yolk, egg albumen, sucrose, whole milk powder (Yotsuba Milk Products Co., Ltd, Sapporo, Japan), and purified water were admixed

Table 3. Effects of rice-feeding and production farm on descriptive sensory characteristics in half-cooked egg yolk and custard pudding analyzed by mixed model procedure

	P-value		
	Rice	Farm	Rice×Farm
Half-cooked egg yolk			
<i>Taste</i>			
Bitter	NS ^a	NS	NS
Salty	NS	*	NS
Umami	NS	*	NS
Koku (body)	NS	NS	NS
Aftertaste	NS	NS	NS
<i>Odor</i>			
Creamy	NS	*	NS
Sweet	NS	*	NS
Brothy	*	NS	NS
Roasted	**	NS	NS
Sulfur	NS	NS	NS
<i>Texture</i>			
Stickiness	NS	***	NS
Fluidity	NS	*	NS
Smoothness	NS	**	NS
Moisture	NS	***	NS
Tenderness	NS	***	NS
Custard pudding			
<i>Taste</i>			
Sweet	NS	NS	NS
Umami	NS	NS	NS
Aftertaste	NS	NS	NS
Koku (body)	NS	NS	NS
Mellow	NS	NS	NS
<i>Odor</i>			
Creamy	*	NS	NS
Sweet	NS	NS	NS
<i>Texture</i>			
Sprnginess	NS	NS	NS
Fineness	NS	NS	NS
Smoothness	*	NS	NS
Moisture	*	*	NS
Tenderness	NS	NS	NS

* $P < 0.05$. ** $P < 0.01$. *** $P < 0.001$.

^a NS = not significantly ($P \geq 0.05$).

at a ratio of 20:40:20:12:105 (w/w/w/w/w), respectively. The mixture was dispensed into a polypropylene cup and cooked by steaming using a steam-convection oven set at 90°C for 20 minutes. After cooking treatment, samples were cooled in refrigerator set at 4°C overnight before sensory evaluation.

Descriptive Sensory Evaluation

A trained panel consisting of 14 panel members selected and trained as described previously (Sasaki *et al.*, 2012), participated in the descriptive sensory evaluation. Participants received additional sessions regarding sensory discrimination of half-cooked egg yolks and custard puddings by a triangle test. The panelists tested the same type of samples

immediately before the actual descriptive sensory test to confirm ranges of the sensory characteristics of the samples.

The sensory sessions were carried out in individual booths illuminated by dark-red lighting in order to prevent the effects of yolk color. The room temperature and humidity were maintained by an air conditioner and a humidifier set at 22°C and 50%, respectively.

Sensory attributes were established by preliminary sensory studies using a Japanese candidate lexicon for eggs (Sasaki and Motoyama, 2016). Sensory attributes used in descriptive sensory sessions and their definitions are presented in Table 2. Sensory attributes used for the cooking procedures are shown in Table 3. Samples were evaluated using 15-cm line scales where 0 cm refers to ‘not perceived’ and 15 cm refers to ‘extremely strong’.

For the sensory test, each panelist received four egg samples (two types of feed from each of the two farms) for both half-cooked egg yolks and custard puddings, in each session. A Latin square design was employed to avoid the effects of the testing order. The sensory trial was carried out every other month for a total of two times in order to adjust for the effects of the sampling period. Panelists received an interval of at least 1 min and rinsed their mouths using bottled purified water between each sample testing.

Prior to the sensory sessions, panel members were informed about the safety of the samples as well as their rights. The subjects then consented to participate in the experiments as sensory panelists.

Statistical Analysis

Statistical analysis were performed using the MIXED model procedure of the SAS system (version 9.12, Cary, NC, USA). Trial, testing order, farm and rice-feeding were designated as fixed effects. The interaction between farm and rice-feeding was also designated. Repeated effect within each panel member in each session was specified using the REPEATED statement of the MIXED SAS procedure. The Akaike Information Criterion calculated by the MIXED procedure in every sensory attribute was used to find the best covariance structure of the repeated effect.. Values are presented as least squares means \pm standard error.

Results and Discussion

The effects of rice-based feed and production farm location on the descriptive sensory characteristics in half-cooked egg yolks and custard puddings analyzed by mixed model procedure are indicated in Table 3. Rice-based feed significantly ($P < 0.05$) affected the ‘brothy’ and ‘roasted’ odor in half-cooked egg yolks and the ‘creamy’ odor, ‘smoothness’ and ‘moisture’ of custard puddings. Differences according to farm location were also observed in ‘salty’ and ‘umami’ taste, ‘creamy’ and ‘sweet’ odor, ‘stickiness,’ ‘fluidity,’ ‘smoothness,’ ‘moisture’ and ‘tenderness’ in half-cooked egg yolks and ‘moisture’ in custard pudding. No statistical interaction between rice-feeding and farm was observed. Figure 1 shows least squares means of sensory intensities of half-cooked egg yolks and custard pudding made from rice-fed and control eggs. In the half-cooked egg yolks category,

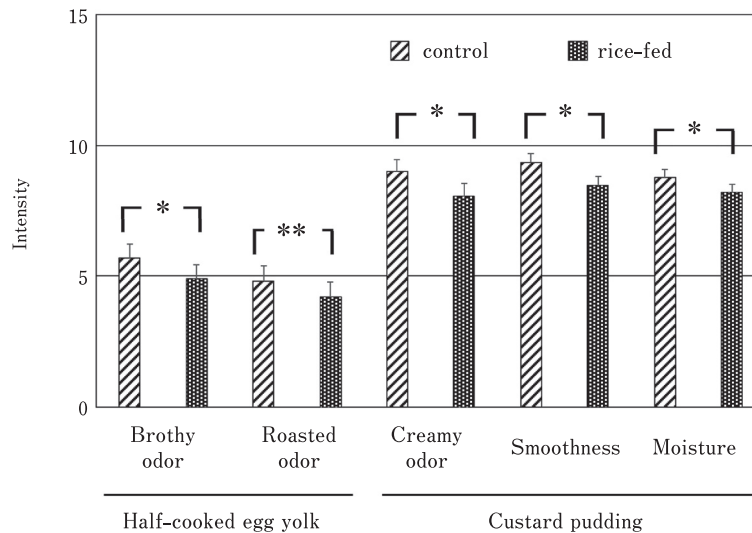


Fig. 1. Scores of sensory attributes that differed between rice-fed and control (corn-fed) eggs cooked to half-cooked yolks and custard puddings assessed by a trained sensory panel. Samples were evaluated using 15-cm line scales from 0-cm=not perceived to 15-cm=extremely strong. Values are expressed as least squares means \pm standard error. Asterisks indicate significant difference between control and rice-fed eggs. *: $P < 0.05$, **: $P < 0.01$.

both the 'brothy' and 'roasted' odors in rice-fed eggs were less intense than those in control eggs. In custard puddings, the 'creamy' odor was less intense in rice-fed eggs than in control eggs. Scores for the texture attributes, 'smoothness' and 'moisture,' were also lower in rice-fed eggs than in control eggs. These results show that rice-feeding in hens decreased odor characteristics regardless of the laying farm. Furthermore, rice-feeding also affected the sensory texture traits of custard pudding.

Previous reports indicated that diet for hens affected sensory characteristics of eggs by changes to the fatty acid profiles (Parpinello *et al.*, 2006; Lawlor *et al.*, 2010; Hwang *et al.*, 2014). Saito *et al.* (2011) indicated that rice-feeding also affected fatty acid profiles of egg yolk. Similarly, the differences in descriptive sensory traits reported here may be due to the changes in fatty acid profiles by rice-feeding.

Cooking procedure is one of the important factors for the sensory characteristics of eggs. Table 3 shows that effects of rice-feeding on sensory characteristics were different between half-cooked yolk and custard pudding. We preliminarily investigated differences in sensory characteristics between rice-fed eggs and conventional eggs by triangle test using a trained panel in four cooking procedures, including half-cooked egg yolks, custard puddings, hard-boiled egg yolks and *chawan-mushi* (Japanese steamed brothy custard), and found that the trained panel could not discriminate between the two types of eggs cooked to hard-boiled egg yolks and *chawan-mushi* (data not shown). Therefore, effects of rice-feeding on sensory properties of eggs may depend on cooking procedures. Appropriate cooking or

processing procedure should be developed to emphasize distinctive characteristics of rice-fed eggs during retail marketing promotions. Here, rice-feeding resulted in decreased flavor intensities in both half-cooked yolks and custard puddings. Rice-fed eggs may be useful for cooking ingredients to complement flavor characteristics of food products other than eggs.

In contrast, as shown in Table 3, several attributes differed between farm A and B. Both A and B farms used the Boris Brown breed of chickens for laying. However, feeding conditions, rice-feeding periods, and age of hens were different between the two farms as presented in Table 1. These factors are generally considered to affect egg quality. The findings here suggest that differences in sensory characteristics between the two farms in this study were due to feeding conditions between the two farms as presented in Table 1. Nevertheless, sensory differentiation by rice-feeding indicated in the study is a definite effect, because such differences were observed in the two farms with different feeding conditions.

In the present study, we presented differences in sensory characteristics between whole rice fed and conventional eggs by descriptive sensory sessions using a trained panel. These findings raise the hypothesis that replacing corn with rice grain in diets for laying hens may be beneficial not only for consumers awareness but for actual eating palatability. To show the benefits of rice-feeding for egg production, consumers' satisfaction of distinctive sensory traits of rice-fed eggs should be investigated in further studies using consumer preference tests. Furthermore, we did not conduct instru-

mental measurement of samples, e.g. yolk color, texture characteristics, and chemical composition. These parameters should also be measured to characterize qualities of rice-fed eggs in future.

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