

Research Article

Study on the Granulation Texture of Salty Yolk

Tian Xianglei, Ruan Meijuan, Zhou Qin and Li Guangpeng
Laboratory of Food Processing and Freshness Preservation, Institute
of Food Engineering and Biotechnology, Tianjin University of
Science and Technology, Tianjin 300457, China

Abstract: The texture of chicken egg yolk, duck egg yolk, salty chicken egg yolk and salty duck egg yolk were tested by the A/BC probe and HDP/SR probe of TA. XT. Plus (Texture Analyzer). Sensory evaluation was made for these yolks. Test results were analyzed and combined with sensory evaluation, a test method that HDP/SR compression test can significantly distinguished cooked fresh yolk and salty yolk apart well was determined, which can indicate the salty yolk's peculiar granulate texture intuitively and accurately.

Keywords: Salty chicken egg yolk, salty duck egg yolk, sensory evaluation, texture analyzer

INTRODUCTION

As our traditional Chinese egg products, salty egg is very popular in home and abroad. Owing to their good preservation and unique flavor, salty eggs have been welcomed by consumers (Suey-Ping and Kuo-Hsuen, 1998). Generally, salted eggs can be made by brining eggs in saturated saline or by coating the egg with salt clods for about 3 to 4 weeks. In addition to directly eat, the salted yolks are also used as stuffing material in some foods such as moon cake, other desserts and glutinous rice dumpling to improve the nutrition and sensory quality of pastry (Thammarat *et al.*, 2011). During salting, the yolk gradually becomes solidified and hardened, part of the lipids in the salted egg yolk became free during to the structural change of low-density lipoprotein induced by dehydration and increase of salt content and more free lipids were released after the cooking process (Chi and Tseng, 1998; Jeffrey *et al.*, 2009). One of the most important characteristics of the cooked salted egg yolks is gritty texture contributed to oil exudation. Effects of salty yolk texture on sensory quality of pastry are remarkable. However, the research mainly focuses on the salting technology improvement; there have been virtually few reports on salty yolk texture published. And the study on salty yolk texture is only concentrated on hardness, flexibility etc. There are no special methods for testing the major texture characteristics, such as compactness and granulation of the salty yolk. The aim of this study was to investigate two methods of texture detection on salty yolk and make correlation analysis with sensory evaluation scores, at last a texture

test method was determined, which can accurately show the granulation feature of salty egg.

MATERIALS AND METHODS

Preparation of salted egg: Fresh chicken eggs, duck eggs were obtained from super-market. Eggs were washed with tap water and left to be dry then brined in saline solution (20% NaCl) at ambient temperature. Six duck eggs designated as a sampling group were tested by texture analyzer with two methods. When the methods were determined, three chicken eggs and three duck eggs were tested every 5 days until salted for 40 days. All the eggs samples were cooked at boiling water for 15mins and left to be cool before tested. All reported datum were average value from the analysis of the three cooked samples. Intact egg yolk was tested by A/BC probe, half egg yolk was tested by HDP/SR probe. The study was conducted in Laboratory of Food Processing and Freshness Preservation at Tianjin University of Science and Technology between April and May 2012.

Other equipments: TA XT Plus Texture Analyzer from British Stable Micro System Company; G>-1000 electric balance from American ShuangJie Co., LTD; Pickle jar from the super-market.

Sensory evaluation: Direct score sensory inspection was used in sensory evaluation. We chose ten persons to assess the texture of cooked chicken egg yolk, cooked duck egg yolk, cooked salted chicken egg yolk and cooked salted duck egg yolk, all the yolk in this experiment were cooked.

Corresponding Author: Tian Xianglei, Laboratory of Food Processing and Freshness Preservation, Institute of Food Engineering and Biotechnology, Tianjin University of Science and Technology, Tianjin 300457, China, Tel.: 15202283925

This work is licensed under a Creative Commons Attribution 4.0 International License (URL: <http://creativecommons.org/licenses/by/4.0/>).

Table 1: Sensory evaluation criteria of the texture on salty yolk

Standard for evaluation	Score
Egg oil outflow, obvious oil droplet, strong granulation feeling	30~40
A little oil droplet and gritty	20~30
Can squeeze oil droplets, granulation feeling, hard	10~20
Hardened and inelastic, hardly any oil and granulation	≤10

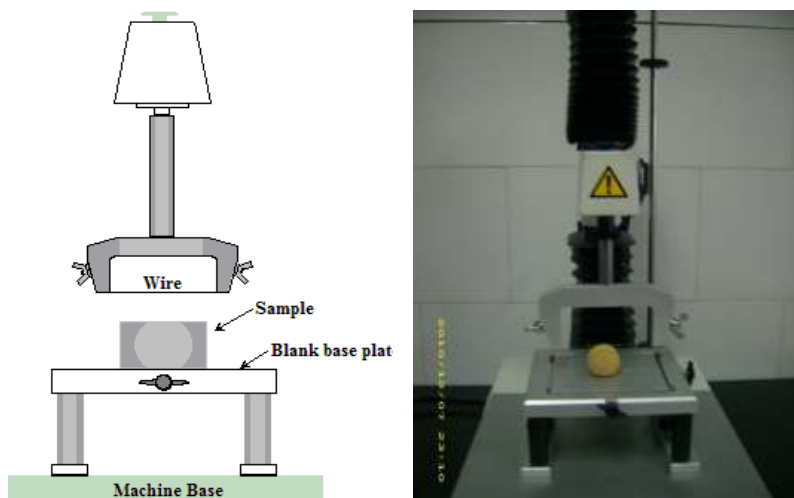


Fig. 1: A/BC cutting device

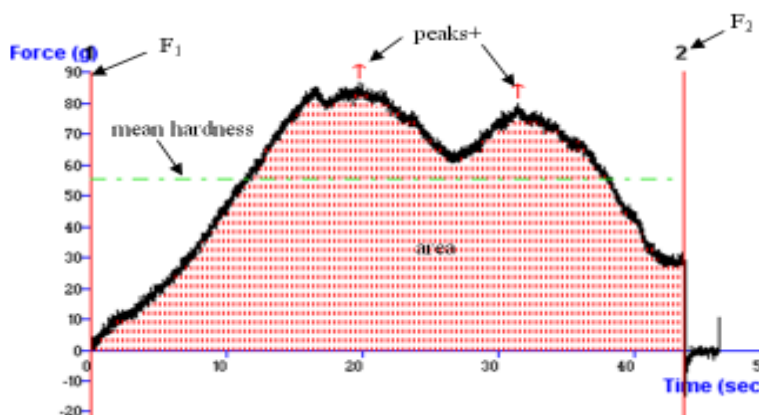


Fig. 2: Characteristic curve with A/BC

Texture evaluation of mouth feel could be combined with test results well, texture of salty yolk was graded with the following standards (Table 1).

Texture test: We chose two texture test methods. One was shear test with A/BC probe, another was compression test with HDP/SR probe. Salted shell duck eggs were cooked by boiling water for 15 min, egg yolk was separated from egg white. The samples for texture test were demanded to keep consistent, cooked egg yolks were crumbly and mealy, so the intact yolks were used to test. The A/BC probe and HDP/SR probe were used for shear test and compression test on yolks respectively. Examine the appropriateness of the two methods by correlating the datum between the sensory evaluation and instrumental analyses, appropriate



Fig. 3: HDP/SR spread ability rig

texture test method of salty yolk was determined through analytic comparison.

Egg yolk shear test (A/BC): The A/BC cutter incorporated a standard 0.3 mm diameter wire which was able to cut through the samples (Fig. 1).

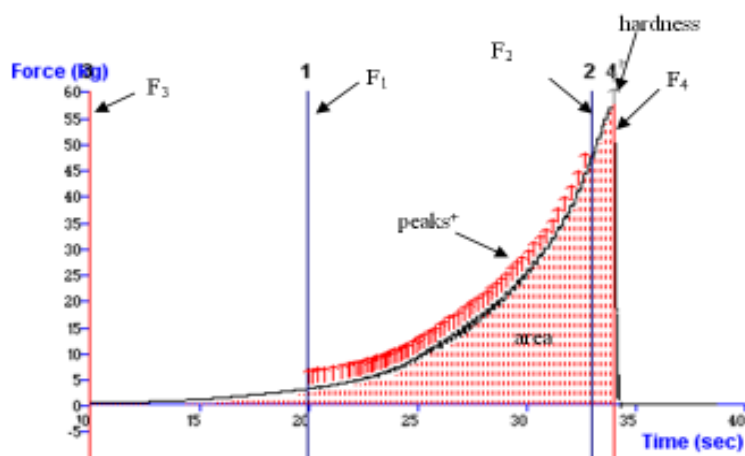


Fig. 4: Characteristic curve with HDP/SR

TA setting of A/BC test: Mode: measure force in compression; option: return to start; pre-test speed: 1.0 mm/s; test speed: 0.5 mm/s; post-test speed: 10.0 mm/s; strain: 98%; trigger type: auto-5 g; tare mode: auto; data acquisition rate: 200 pps.

Put the intact yolk on the center of the heavy duty platform, commenced the test immediately, characteristic curve was shown in Fig. 2.

Hardness: The force required when samples reach a certain extent deformation. The salty yolk's loose and soft characteristic was indicated by the mean hardness from the curve between the two selected anchors F_1 and F_2 , the greater the cutting force was, the firmer the sample was. The area between the two selected anchors F_1 and F_2 indicated the hardness of the salty yolk on the other side.

The granulation characteristic was counting the number of positive going force- ($\text{peak}^+ \geq 10$ g) between the selected anchors: F_1 and F_2 , the more the peaks were, the grittier the yolk was. The length of an imaginary line joining all points in the selected region (between the anchors) was called linear distance, the length of the linear distance could show the granulation characteristic from another side.

Egg yolk spread ability test (HDP/SR): The Spread ability Fixture was a set of precisely matched male and female perspex 45° cones (Fig. 3). The fixture came with five replaceable female cone sample holders which could be filled in advance of testing and then easily locked into the base holder precisely centre under the matching upper cone probe.

TA setting of HDP/SR test: Mode: measure force in compression; option: return to start; pre-test speed: 1.0 mm/s; test speed: 0.5 mm/s; post-test speed: 10.0 mm/s;

distance: 17 mm; trigger type: auto-5 g; tare mode: auto; data acquisition rate: 200 pps.

The salty duck yolks were cut into two halves in the previous test, one of the half yolks was put into the female cone, if the half yolk was exceed the edge of the female cone, cut off the unnecessary part with a knife then commence the test immediately.

Characteristic curve as follows: Hardness was defined as the maximum peak force when the test ended as shown in Fig. 4, the salty yolk's loose and soft characteristic was indicated by the force F_4 and the area between F_3 and F_4 . The test hardness and area were used to indicate the hardness of the yolk.

The salty yolk's granulation characteristic was counting the number of positive going force ($\text{peak}^+ \geq 10$ g) and the linear distance between the selected anchors: F_1 and F_2 .

RESULTS AND DISCUSSION

Determination of the method on salty yolk: The salty duck yolk was tested six times with A/BC and HDP/SR probe, respectively the results and analysis were discussed in the following paper.

Stability studies of texture measuring with A/BC: Variation Coefficient (V.C.) was a measured data of each observation variation degree. The same sample test results should have good reproducibility, the bigger of V.C. the poorer of the reproducibility. As shown in Table 2 and Fig. 5, V.C. of peaks and linear distance were less than 20%, which indicated that the test results repeatable well. The C.V. of the hardness and area were close to 30%, which indicated that the two index results was unsteady and had a bad repeatability. So this method was improper to indicate the hardness of salty

Table 2: Texture results with A/BC

Sample	Hardness/g	Area/kg.sec	Peaks ⁺	Linear distance/kg.sec
1	108.02	6.25	4	59.71
2	67.02	3.72	4	57.26
3	112.24	6.78	5	62.33
4	72.39	3.64	3	51.79
5	75.60	4.49	4	61.28
6	137.89	7.00	5	58.93
Average	95.53	5.31	4.17	58.55
S.D.	28.20	1.54	0.75	3.76
C.V./%	29.52	29.07	18.07	6.42

Table 3: Sensory evaluation points and the texture results with A/BC

Sensory evaluation scores	Hardness/g	Area/kg.sec	Peaks ⁺	Linear distance/kg.sec
27	108.02	6.25	4	59.71
30	67.02	3.72	4	57.26
31	112.24	6.78	5	62.33
29	72.39	3.64	3	51.79
33	75.60	4.49	4	61.28
32	137.89	7.00	5	58.93

Table 4: Correlation analysis of sensory evaluation points and yolk texture with A/BC

	S.E.	H	A	P	L.D
S.E.	1				
H	-0.0367	1			
A	-0.1433	0.9577**	1		
P	-0.0410	0.7747	0.8316*	1	
L.D	-0.4571	0.4390	0.6348	0.7721	1

Table 5: Texture results with HDP/SR

Sample	Hardness /kg	Area /kg.sec	Peaks ⁺	Linear distance/kg.sec
1	8.54	53.88	145	56.76
2	11.60	73.36	149	57.49
3	9.86	59.91	160	65.14
4	9.35	62.91	169	57.70
5	12.19	78.38	153	61.74
6	11.02	76.36	155	68.09
Average	10.55	67.47	155.17	61.15
S.D.	1.61	9.96	13.55	4.67
C.V./%	15.28	14.76	8.74	7.63

yolk. Correlation analysis with sensory evaluation was made to figure out whether the test results had impact on the sensory evaluation and whether this method was feasible or not.

Correlation analysis of physical properties and sensory evaluation with A/BC: The statistical analysis system (Origin 8) was adapted to perform Pearson correlation coefficient (or Pearson product-moment correlation coefficient which was a linear correlation coefficient). Confidence level for ellipse was 95%. The results of the Hardness (H), Area (A), Peaks (P) and Linear Distance (L.D) was combined with sensory Evaluation Scores (S.E.) of the yolk texture.

The sensory evaluation scores and the texture results with A/BC were shown in Table 3.

In Table 4, area and peaks were positive significant correlation, area and hardness were extremely significant correlation, but the evaluation scores had no significant correlation with any of the A/BC test results. This shear test method could not combine with sensory evaluation well and the repeatability of the test results was poor, so it was improper to test salty yolk.

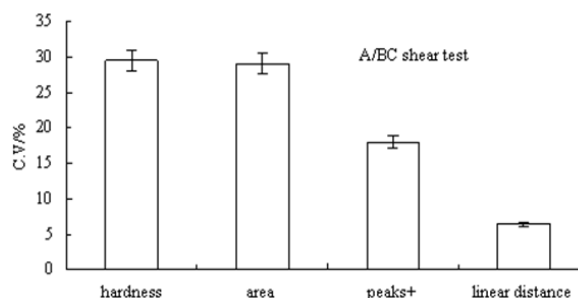


Fig. 5: Coefficient of variation of four texture results with A/BC

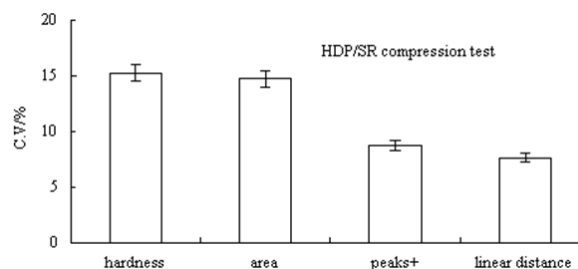


Fig. 6: Coefficient of variation of four texture results with HDP/SR

Stability studies of texture measuring with HDP/SR:

As shown in Table 5 and Fig. 6, the C.V. of the four indicators were all below 20%, they all had good reproducibility, especially the peaks and linear distance, the C.V. were less than 10%, which indicate this method had a better repeatability. On the whole, this compression test with HDP/SR was more stable than the shear test with A/BC. Correlation analysis with sensory evaluation was made to figure out whether the texture results had appreciable impact on the sensory evaluation.

Correlation analysis of physical properties and sensory evaluation with HDP/SR: As shown in

Table 6: Sensory evaluation points and the texture results with HDP/SR

Sensory evaluation scores	Hardness /kg	Area /kg.sec	Peaks ⁺	Linear distance kg.s
27	8.54	53.88	145	56.76
30	11.60	73.36	149	57.49
31	11.02	59.91	155	65.14
21	12.94	62.91	153	57.70
33	9.35	78.38	169	61.74
32	9.86	76.36	160	68.09

Table 7: Correlation analysis of sensory evaluation points and yolk texture with HDP/SR

	S.E.	H	A	P	L.D
S.E.	1				
H	-0.0502	1			
A	0.0926	0.9279**	1		
P	0.9118*	-0.1640	-0.0542	1	
L.D	0.3399	0.2934	0.3951	0.1832	1

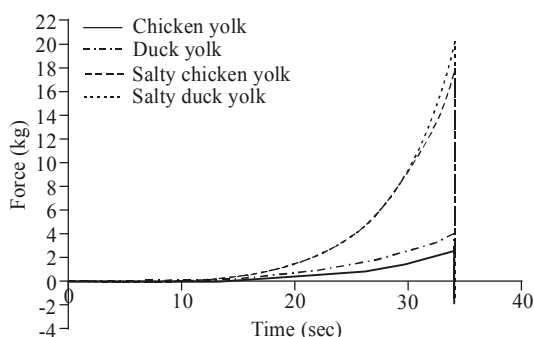


Fig. 7: Graph of HDP/SR probe on different egg yolk

Table 6 and 7, the sensory evaluation points and peaks number of salty yolk were positive significant correlation, hardness and area were extremely significant, the harder of the salty yolk was, the bigger of the area was, which mean chewing the salty yolk need more strength. In the sensory evaluation, granulation feeling was an important characteristic, peak number was tested by HDP/SR probe, which imitated human mouth feel on the granulation characteristic of salty yolk and so peak number had great influence on the edible quality. The coefficient of correlation was 0.9118, which indicated that they were positive correlation. The test results had good repeatability and correlation with sensory evaluation, so the compression method with HDP/SR was more suitable for testing the yolk.

Results and analysis of different yolk with HDP/SR:

The chicken egg yolk, duck egg yolk, salty chicken egg yolk (salted 25 days), salty duck egg yolk (salted 25 days) were all boiled 15 min and tested separately. The tested curve and date was shown in Fig. 7 and Table 8.

As Table 8 shown, the salty yolk got higher sensory evaluation score and salty duck egg yolk got higher evaluation score than salty chicken yolk. The

Table 8: HDP/SR texture test data of different egg yolk

Samples	Sensory evaluation scores	Hardness/ kg	Area/kg sec	Peak ⁺	Linear distance/kg.s
Chicken egg yolk	19.5	2.62	19.35	2	13.51
Duck egg yolk	21	3.97	32.20	9	14.28
Salty chicken egg yolk	30	18.51	107.72	113	26.79
Salty duck egg yolk	33.5	17.79	98.28	160	89.49

Table 9: Correlation analysis of sensory evaluation results and yolk texture on different yolks

	S.E.	H	A	P	L.D
S.E.	1				
H	0.9697*	1			
A	0.9560*	0.9973**	1		
P	0.9979*	0.9600*	0.9417	1	
L.D	0.8365	0.6804	0.6389	0.8581	1

salty yolk had more intensive peaks than cooked egg yolk, the peak numbers of salty duck egg yolk was a litter more than salty chicken egg yolk. So this method can separate the cooked yolk and salty yolk objectively. The salted yolk's hardness increased obviously, chicken egg yolk was stiffer than duck egg yolk. During brining, NaCl migrated from saline through eggshell into albumen and then to yolk. At the same time, dehydration also occurred in albumen and yolk. Both effects of NaCl diffusion and dehydration would cause hardening of yolk and the more water was removed, the tighter the yolk spheres were packed (Kaewmanee *et al.*, 2009). Salty yolk's main features "oil extrudation" was due to the protein denaturation which make protein and fat emulsion system destroyed, fat was free from the original emulsion system (Lai *et al.*, 1999; Woodward and Cotterill, 1987). Cooking is the essential process for producing the final yolk products.

The lipids in egg yolk were mostly contained in LDL, which existed in yolk plasma (Gilbert, 1971). After brining, part of the lipids in salted egg yolk became free during to the structural change of LDL induced by dehydration and increase of salt content (Lai *et al.*, 1997) furthermore; more free lipids in salted egg yolk were released after the cooking process which was contributed to the gritty texture and make the salty yolk taste good.

Correlation Analysis was made between results of sensory evaluation, the results were shown in the Table 9.

Table 9 shows the hardness, area, peaks number are positive significant correlation with sensory point, but the peaks number and sensory evaluation had the maximal coefficient of correlation 0.9979, which indicated that the stronger gritty mouth feeling, the more peaks. Hardness and area were extremely positive significant correlation, so we could use the two indexes to indicate compactness of egg yolks. The peaks number could indicate the granulation texture and oil extrudation.

CONCLUSION

In this study we mainly discussed two methods to test salty yolk with texture analyzer, A/BC shear test and HDP/SR compression test, after repeatability and correlation analysis with sensory evaluation separately, HDP/SR compression test can significantly differentiated cooked fresh yolk and salty yolk well. Especially counting peak which showed the characteristics vividly could reflect the salty yolk's specific granulation characteristic to some extent. This test method could be put to good use in salty yolk's texture test.

REFERENCES

- Chi, S.P. and K.H. Tseng, 1998. Physicochemical properties of salted pickled yolk from duck and chicken eggs. *J. Food Sci.*, 63: 27-30.
- Gilbert, A.B., 1971. The Egg: It's Physical and Chemical Aspects. In: Bell, D.J. and B.M. Freeman (Eds.), *the Physiology of the Domestic Fowl*. Academic Press, London, UK, 3: 1379-1409.
- Jeffrey, A.B., F.F. George and C.F. Frederick, 2009. Rheological properties of dispersions of spherulites from jet-cooked high-amylase corn starch and fatty acids. *Cereal Chem.*, 86(1): 76-81.
- Kaewmanee, T., S. Benjakula and W. Visessanguanb, 2009. Changes in chemical composition, physical properties and microstructure of duck egg as influenced by salting. *Food Chem.*, 112: 560-569.
- Lai, K.M., W.C. Ko and T.H. Lai, 1997. Effect of NaCl penetration rate on the granulation and oil-off of the yolk of salted duck egg. *Food Sci. Technol. Int. Tokyo*, 3: 269-273.
- Lai, K.M., S.P. Chi and W.C. Ko, 1999. Changes in yolk states of duck egg, during long-term brining [J]. *J. Agric. Food Chem.*, 47(2): 733-736.
- Suey-Ping, C. and T. Kuo-Hsuen, 1998. Physicochemical properties of salted pickled yolks from duck and chicken eggs. *J. Food Sci.*, 63: 27-30.
- Thammarat, K., B. Soottawat and V. Wonnop, 2011. Effects of salting processes and time on the chemical composition, textural properties and microstructure of cooked duck egg. *J. Food Sci.*, 76: 139-147.
- Woodward, S.A. and O.J. Cotterill, 1987. Texture and microstructure of cooked whole egg yolks and heat-formed gel of stirred egg yolk. *J. Food Sci.*, 52: 63-67.