Research Article
Effect of Sodium Stearoyl Lactylate on Refinement of Crisp Bread and the Microstructure of Dough

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Abstract: Crisp bread, as a new type of bread, had a stronger hardness, fracturability and a finer texture compared with the tradition hard bread. The objective of this study was to test whether Sodium Stearoyl Lactylate could change the microstructure of dough and improve the texture of crisp bread. Two probes used were P/2 and P/2N and these graphs were calculated by several means. Results of these calculation showed that number of positive peaks of 5-6 sec, as the most appropriate process method, had the minimum coefficient of variation and the maximum correlation with sensory evaluation. After observing the microstructure of dough and testing the texture of crisp bread, it was concluded the addition of SSL promoted a tighter dough structure and improved the quality of bread significantly. The optimal addition dosage was 0.3%.

Keywords: Crisp bread, microstructure, Sodium Stearoyl Lactylate, texture

INTRODUCTION

Having a stronger hardness, fracturability and a finer texture, crisp bread which is different from hard bread in formula and its production process needs less ingredient, less water, more times pressing the dough and longer baking time. More kinds of snacks can be made by flavoring or reshaping the crisp bread. Hardness and fracturability are view as two important indicators however the refinement is a more significant one which can response the quality of bread when optimize the formula. As a result, finding out an applicable texture test measurement to guide the crisp bread is necessary.

Since the texture analyzer possess the unique characteristic, that is recording the force during the test process and then analyzing the food texture characteristics by the graph, its use in baking food has been increasing. A scientific valuation method of bread had been raised and the relationship between bread texture and bread structure had been reported (Peiyan, 2009); the quality of bread was related with dough hardness, harder the dough bigger the bread, which could forecast the quality of bread (Dobraszczyk, 2002); The method of testing the bread texture to improve the product quality had been application (Abu-Ghoush et al., 2008; Christiansen et al., 2003).

Emulsifier was frequently added to bread to improve bread-making performance, reduce surface tension among components to form a more uniform dispersions so as to improve the bread texture and taste; combining with protein and starch to modify the structure of bread and extend shelf-life; controlling fatty structure to perfect quality of fat-rich foods (Zhongdong, 2001; Jianwei et al., 2010). There was not obvious difference in volume between SSL addition was 0.1% and vegetable oil addition was 2-3%.

Recently the development and application of scanning electron microscope making it was much more intuitionistic to having a good grasp of effect of components and production process. The main objective of this study was to examine the effects of the addition of SSL in crisp bread. The Texture Analyser was used to determine the finest texture of crisp bread. The dough structures were observed with scanning electron microscope. And these were contributed to determine the relation of dough structures with crisp bread texture and optimize the texture of crisp bread.

MATERIALS AND METHODS

Commercial flour, sugar, salt, shortening, yeast were obtained from local market. Sodium Stearoyl Lactylate, xanthan gums were obtained from Danisco Company. Glutaraldehyde, ethanol and saline were obtained from Sinopharm Chemical Reagent Co., Ltd. All reagents were of analytical grade.

MB-500/MB-100 DIY private Toaster was obtained from the North American Electric (Zhuhai) Co., Ltd. FJX-15 Luxury spray bread fermenting box was obtained from Cheng Kang Co., Ltd., XYF-2E-3P Infrared food oven: Guangzhou Hongling Electric Equipment Co., Ltd. TA.XT. Plus Texture Analyzer

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was obtained from British Stable Micro System Company. SEM was used in this study.

Production of crisp bread: Flour, sugar and salt were stirred in the flour-mixing machine and then shortening was added in it. After stir the dough, put it into the fermenting box. 40 min later took it out, cut and rolled until the dough was shaped stripe. Then baked at 180C/160◦C for 40 min. Production was removed from pans and cooled at room temperature.

Sensory evaluation of refinement of crisp bread: Choosing 10 experienced evaluators scored to each sample. The scores were from 0 to 30 which the vent of crumb was uniform and fine.

The texture analysis of refinement of crisp bread: The 35 mm cylindrical bread was made through cutting the front and end side. Using the probe of P/2, P/2N of TA. XT. Plus texture analyzer to detect the texture, recorded the time curve based on the speed of 1.0 mm/sec.

- **Parameter and typical figure of p/2:** The compression experiments carried out using the p/2 probe to detect the texture of crumb. The Pre-test speed was 1.5 mm/s, testing speed was 1 mm/s, the speed of after testing was 10 mm/s, distance of pressure was 6 mm and trigger force was 10 g. Typical Figure of P/2 as follow: Number of positive peaks and average drop off of 2-5s were calculated through Fig. 1.

- **Parameter and typical figure of p/2N:** The Pre-test speed was 1.5 mm/s, testing speed was 1 mm/s, the speed of after testing was 10 mm/s, distance of pressure was 6mm and trigger force was 10 g. Typical Figure of P/2N as follow:

Number of positive peaks and average drop off of 2-5s and 5-6s were calculated through Fig. 2.

To determine the best objective measurement of the texture of the crumb, we evaluated the variation
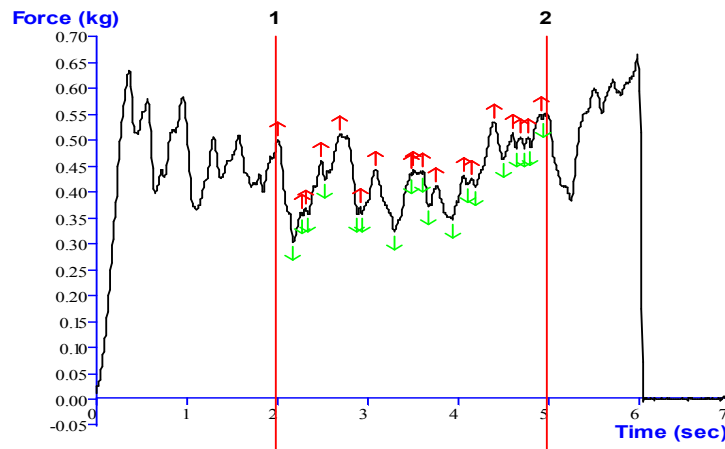

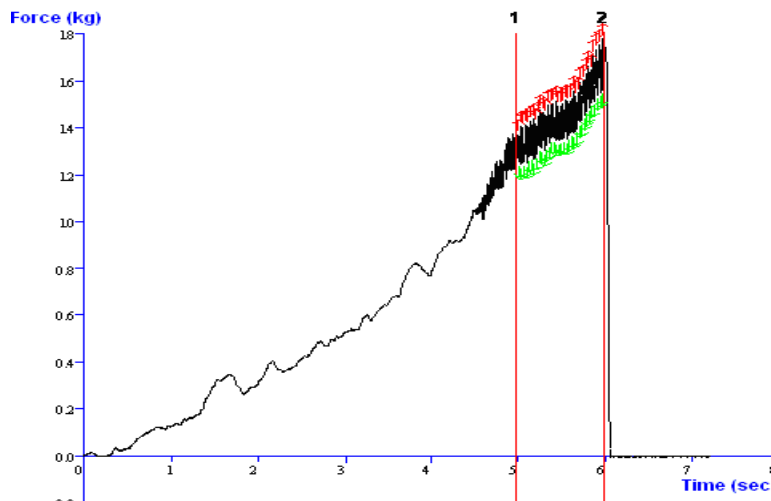Fig. 1: Typical Figure of P/2

Fig. 2: Typical Figure of P/2N

coefficient of the results by using different probes and different calculation methods, as well as the sensory scores of the texture.

The effect of different adding amount of SSL on the microstructure in the dough preparation of dough: The fermentative dough contained different SSL adding amounts, which are respectively 0%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0,35%, 0.4% (flour weight basis) and it was cut into 25 mm length and 5 mm width . Put it into 25mL/L glutaraldehyde solution overnight. Then washed three times using 1‰ saline, after that employed the ethanol solution of 30, 50, 70 and

90% for elution, 10 min for each concentration gradient. After which the samples should also be freeze-dried, finally painted gold, observed and took pictures using SEM.

RESULTS AND DISCUSSION

The study of testing method of texture in TA-texture:
The stability of the results from different probes and calculation method: As could be seen from the Table 1, the coefficient of variation from the same samples was the minimum 2.556 far smaller from the

Table 1: The compare of the results of P/2 and P/2N

Probe	P/2		P/2N			
Method of calculation	Number of positive peaks at 2-5s	The average drop off at 2-5s	Number of positive peaks at 2-5s	The average drop off at 2-5s	The number of positive peaks at 5-6s	The average drop off at 5-6s
Test 1	14.000	0.065	44.000	0.047	34.000	0.158
Test 2	21.000	0.045	42.000	0.030	34.000	0.030
Test 3	18.000	0.049	38.000	0.044	35.000	0.147
Test 4	14.000	0.078	44.000	0.052	36.000	0.141
Test 5	15.000	0.070	35.000	0.050	35.000	0.131
Test 6	14.000	0.042	37.000	0.047	36.000	0.071
Average	16.000	0.058	40.000	0.045	35.000	0.113
(S.V.)	2.898	0.015	3.847	0.008	0.894	0.051
coefficient of variation /%	18.114	25.508	9.790	19.160	2.556	45.051

Fig. 3: Definition of drop off

$$y = 1.891x - 46.237$$
$$R^2 = 0.9515$$
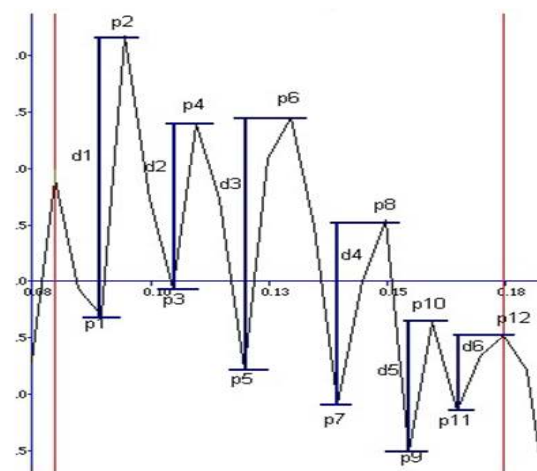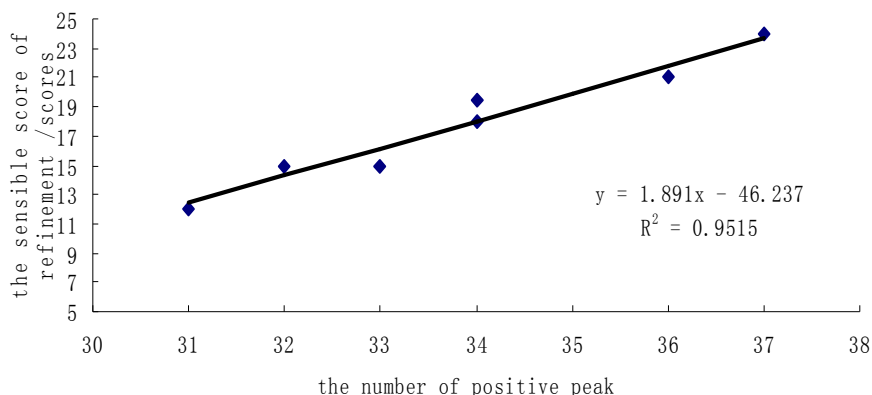
Fig. 4: The correlation of the sensible scores of refinement and the number of positive peak

others when calculating the positive peak value at 5-6s of the P/2N probe. Thus this method was reasonable and could evaluate objectively the refinement of crumbs as one indicator. The reason is that the hardness of the sample was consistent and the force during pressure was stable through P/2 a diameter of 2 mm cylindrical probe. Fluctuations of result may reflect the size of the pores of crumb. As the depress distance grows the interface increases, the number of the pores grows, as a result, from the P/2N graph, the force getting stronger. So the results are more realistic. During texture test, the number of positive peak is for the how much the samples force fluctuate within the tested area, which can be used to illustrate the crispness and grainy of the samples. The method for calculation the average drop off was shown in the Fig. 3. To calculate the average drop off within the selected area, d_1, d_2, d_3, d_4, d_5, d_6 were the drop off,p_2, p_4, p_6, p_8, p_{10}, p_{12} (the unit is based on the unit of Y axis which shows the minimum force) were the positive peak value, p_1, p_3, p_5, p_7, p_9, p_{11} were the negative peak values and $d_1 = p_2 - p_1$, so what the average drop off could revel the degree to which the force is changed , that was the fluctuation of the sample force, regardless of the positive peak number.

The correlation between the subjective and objective evaluations for the crisp bread: Calculating the sensible score for different samples and the number of positive peak at 5-6s for probe P/2N, analyzing the correlation between the results from the subjective and objective evaluations, as the Fig. 4 shows, the maximum coefficient can reach 0.9515, proving the correctness of the objective determination, thus the measured values for texture can study as the indicator of refinement of crisp bread. That is, the more positive peak numbers, the more fine.

The effect of SSL on the microstructure of the dough: As we can see from the graph, SSL had the effect of reducing the size and increasing the density of the pore. From the Fig. 5, we could see that the ones without SSL had many granular starches in the free state on the surface of the dough, which looked rather loose. When adding 0.1% SSL, nearly no change for the pore size but increased density, meanwhile the starch was packed in the protein structure, which made the dough much tighter (Fig. 6). As we gradually increased the amount, 0.15%-0.25%, pores get smaller while density grows and the dough gets tighter (Fig. 7 to 9). When reaching 0.3%, the uniformity of the pore reached the best level (Fig. 10). If more than 0.3%, the pore comes into a hole (Fig. 11 and 12). As discussed above, because SSL could tie the protein, starch, lipid
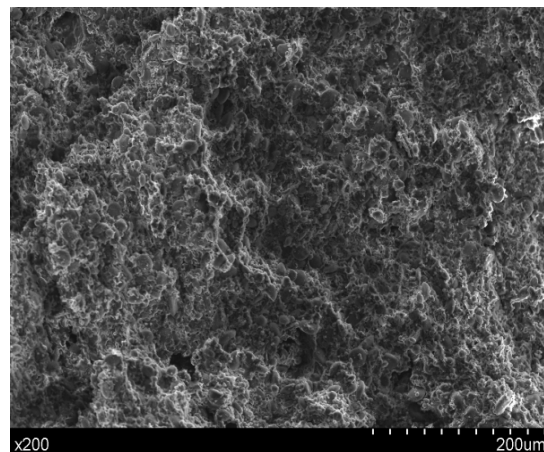

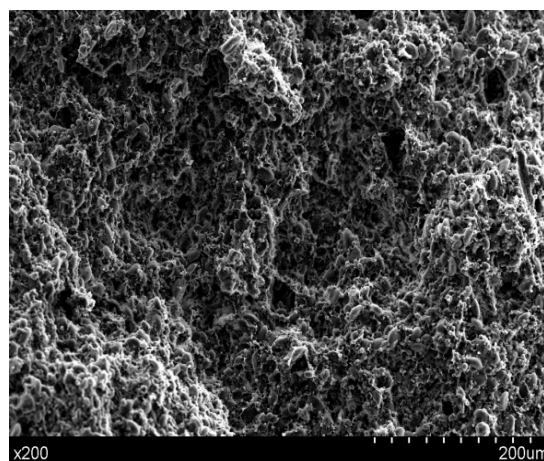Fig. 5: Microstructure of dough without SSL addition

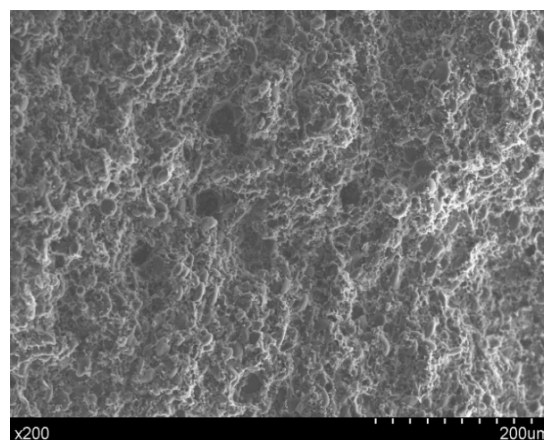Fig. 6: Microstructure of dough with 0.1% SSL addition

Fig. 7: Microstructure of dough with 0.15% addition

together, which made stronger combination, however over dose could cause bigger hole.

The effect on the refinement of the crisp bread: As we could see from the Fig. 13, when the adding amount
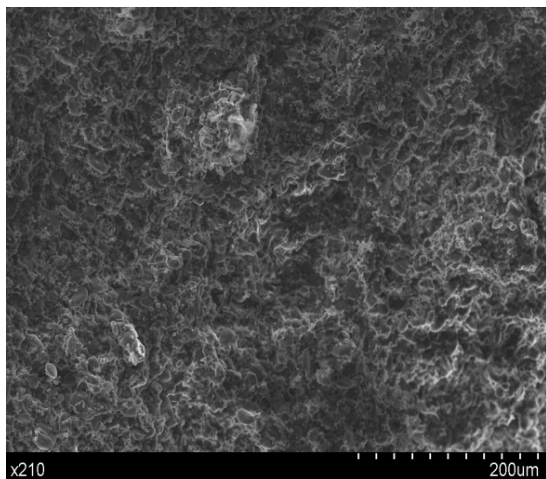
Fig. 8: Microstructure of dough with 0.2% SSL addition
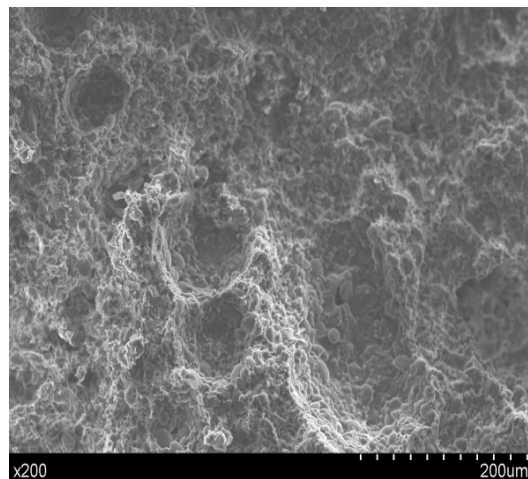

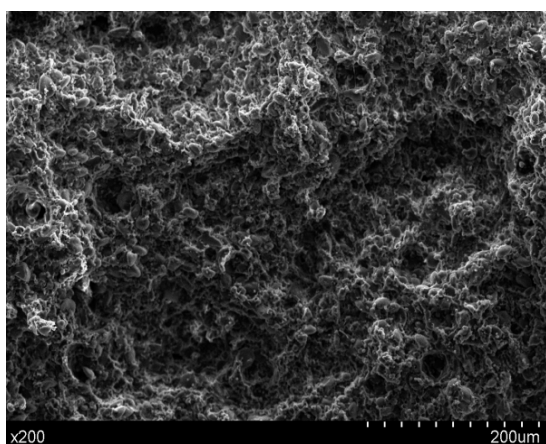Fig. 11: Microstructure of dough with 0.35% addition
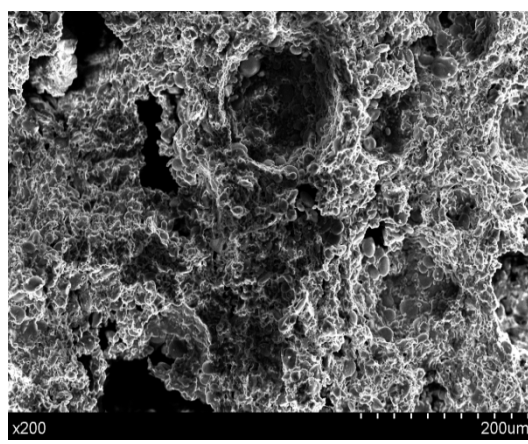

Fig. 9: Microstructure of dough with 0.25% addition

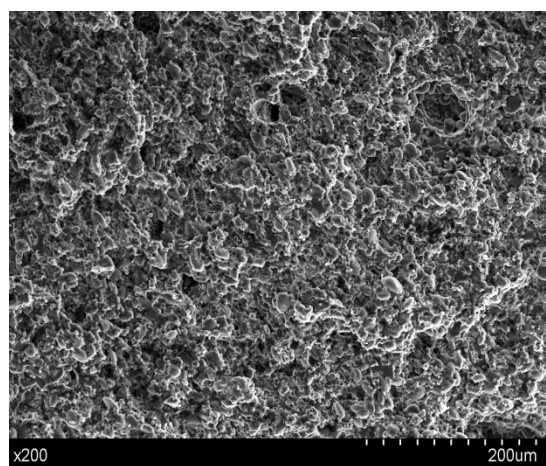Fig. 12: Microstructure of dough with 0.4% SSL addition

decreased greatly and even lower than the ones without addition.

The conclusions as follow:

- SSL can improve the texture of crisp bread, within a certain amount, the number of positive peak outnumber the ones without additive.
- The texture of crumb reaches to finest as the adding amount is 0.3%. As emulsifier, SSL can tie the protein and starch together, increase the resistance to mechanical stir, so decrease the number of uneven pore caused by the over stirring, at the same time, decrease the surface tension between the ingredients, which will help to form the uniformity, improve the organization and enhance the taste. But if the additive was excess, the dough will stick together and big hole will form because of emulsifier combining with too much protein and starch.

The relation between the microstructure and refinement of the crisp bread: As discussed above the

Fig. 10: Microstructure of dough with 0.3% SSL addition

was 0.1%-0.2%, the number of positive peak was growing up a bit , 0.2%-0.3% the positive peak number increased dramatically, 0.3%, the refinement reached the best , more than 0.3% , the number of positive peak
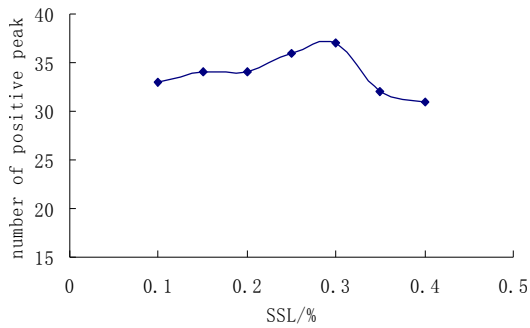
Fig. 13: Number of positive peak of crisp bread added with different levels of SSL

impacts of SSL on the dough microstructure and refinement of the crisp bread are along the same line, that is, the smaller dough pore, the high density, the tighter structure and finer of the texture. Among them the closeness of the dough has the greatest influence on the quality of the bread. By the way of analysis, the dough could be baked into crisp bread, during this process, the CO_2 overflow from the gap of the dough, formed the pore in the crisp bread, the dough which hold more gas will affect the bread volume.

CONCLUSION

The study aimed to find out the best possible way to detect the refinement of the crisp bread by using the probe P/2 and P/2N. SSL could improve the consistency and refinement of the crisp bread. Funded out the effect of SSL on the microstructure of the dough and the texture of crisp bread, combined the sensory evaluation and SEM.

- The correlation between the number of positive peak at 5-6s for probe P/2N, which viewed as the indicator of refinement of crisp bread and the sensory evaluation reached the maximal, 0.9515.
- The optimal addition of SSL was 0.3%, at that time, the pore of dough reached minimum, the density of dough and the refinement of crisp bread reached maximal.

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