

## Research Article

### Study on Formula of Nutrient Bread Composite of Multiple Vegetables

<sup>1</sup>Xianhui Sun, <sup>2</sup>Yongsheng Ma and <sup>3</sup>Tongqing Ma

<sup>1</sup>College of Agricultural Engineering, Weifang Vocation College, Weifang, Shandong, 261041, P.R. China

<sup>2</sup>Chemistry and Chemical Engineering and Environment Engineering College,

<sup>3</sup>International College of Beihai, Weifang University, Weifang, Shandong 261061, P.R. China

**Abstract:** Nutrient bread composite of multiple vegetables was produced from the bread dough containing multiple vegetables which were pulped. The color of the finished bread product which was produced from dough added in different color vegetables pulp was compared. Carrots, pumpkins and sweet potatoes were selected as main raw vegetable materials of nutrient bread. It was determined that the optimal pre-cooking time of pumpkin, sweet potatoes and carrots was 3 min, 4 min and 5 min from comparing beating results. The process quality of bread dough added in different dosage of vegetable pulp and the flavor of finished bread containing different dosage of vegetable pulp were studied. The optimal formula of nutrient bread composite of multiple vegetable pulp was that the weight ratio of pumpkin pulp, carrot pulp and sweet potato pulp was 2:1:1, the best addition amount of composite vegetable pulp was 32.5% of the flour weight.

**Keywords:** Carrot, composite vegetable pulp, formula, nutritional bread, pumpkin, sweet potato

## INTRODUCTION

With the accelerating of life rhythm, the demand of convenience foods is growing. Baked goods, such as cakes, bread and cookies are convenient to be eaten. Especially bread has become staple food for breakfast for the part of domestic people. At present baked goods on the market are mainly produced from grain, especially wheat flour, so nutrients are single. Bread used as staple food requires wheat flour gluten with high quality, vitamins and dietary fiber content of the bread product is low. Few varieties of bread contain vegetable which mainly is single vegetable powder (Wang *et al.*, 2012; Gao *et al.*, 2013; Zhang *et al.*, 2011; Zhang, 2009) or used as a filling to be added (Li, 2010). It is rare that multiple vegetable is added in dough of bread to produce nutritional bread composite of vegetable (Dnasby and Bovell-Benjain, 2003).

Now demand for nutrition of people is more and more balance (Guarda *et al.*, 2004). Nutritional bread composite of multiple vegetable can meet the needs of balanced nutrition of people. Nutritional bread composite of multiple vegetable developed in this study can realize the organic combination of vegetables and baking food, achieve complementary nutrition. We think the nutritional bread has very broad market space.

## EXPERIMENTAL

**Materials:** Vegetables that are purchased from local market in Weifang city include carrots, pumpkin (long form), sweet potatoes, spinach, celery, cucumber.

**Other materials:** Bread flour, Angel instant active dry yeast (resistant to high sugar), white sugar, eggs, Anchor butter, salt, milk, bread improvers, Arowana soybean oil.

**Main experimental equipment:** SZM-20 multifunction egg beater produced by XuZhong Company, SEC-2Y-P oven additional proofing box produced by SanMai Company, KS-520 multifunction home blenders, induction cooker, electronic scales, 60 mesh filters.

**Process:** Common sweet bread process with single fermentation was used as basic technology in this study. Formula of common sweet bread was that bread flour was 100 parts, water was 55 parts, instant active dry yeast was 1 part, salt was 0.5 part, white sugar was 15 parts, butter was 5 parts, eggs was 5 parts, milk was 4 parts, bread improver was 0.2 parts. The amount of complex vegetable pulp added into bread dough and

**Corresponding Author:** Xianhui Sun, College of Agricultural Engineering, Weifang Vocation College, Weifang city, Shandong province, 261041, P.R. China, Tel.: 086-13964712060

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

optimum formula of nutrient bread composite of multidimensional vegetable was studied with this common bread recipe as basic technology.

**Preparation of multidimensional complex fruit/vegetable pulp:** Selection of raw materials→pretreatment→precooking→beating→filtering→mixing→multiple complex fruit/vegetable pulp was obtained.

**Process of nutrition bread (single fermentation process):** Mixing of bread flour, water, yeast, improvers and sugar→stirring (oil and salt was added in late stage) with adding of complex vegetable pulp→dough fermenting→block, rubbing circles, standing→bread forming→final proofing→baking→cooling→packaging→product.

## RESULTS AND DISCUSSION

**Selection of the complex vegetable type:** The common green vegetables including spinach, celery, cucumber and yellow lines vegetables including pumpkin, yellow heart sweet potato, carrots in market were beaten to vegetable pulp respectively. Then the vegetable pulp was kneaded into dough instead of the 50% of the water. Round bread was produced with single fermentation process as basic technology. The color of the final bread was compared. The results were shown in Table 1.

It can be seen from Table 1 that surface color of baked product containing green line vegetables was gray which color affected the sensory quality of the product. Yellow or golden color bread product was obtained after adding yellow vegetables pulp to dough. Yellow or golden color that can arouse people's appetite enhanced the sensory quality of the product. So, yellow

vegetables including carrots, pumpkin and sweet potato were selected as raw material of composite vegetables.

**Preparation of vegetable pulp:** Pumpkin, sweet potatoes and carrots were peeled and cut into flake which thickness was about 0.5 cm. Vegetable flake were pre-cooked in boiling water for several minutes, then were beaten with multifunction beater and filtrated with 60-mesh screen to remove vegetables tissue that was not grinded. The influence of pre-cooking time of carrots, pumpkin and sweet potatoes to beating process was shown in Table 2.

It can be seen from Table 2 that in order to get good vegetable juice, fully improve the utilization of raw materials and reduce nutrients loss, pre-cooked time before beating of pumpkin, sweet potato and carrots were determined as 3, 4 and 5 min.

**Sensory evaluation of multiple vegetable pulps complex:** Vegetable pulps were mixed in different proportions. Sensory evaluation including flavor evaluation and color evaluation was done by 15 teachers and students which were selected randomly from our academy. Sensory evaluation was repeated 3 times. The evaluation results were shown in Table 3.

It was seen from Table 3 that the effects of ratio on color was not particularly obvious, the effect on the flavor was obvious. Most people tend to the ratio with low carrot pulp content and high sweet potato pulp content.

**Influence of vegetable pulps complex on dough process performance:** Four kinds of bread dough were made using the pumpkin pulp, potato pulp, carrot pulp and water respectively. Formation time of dough, sticky elasticity and toughness as well as expansion

Table 1: Color comparison of bread dough and bread product after adding different vegetable pulp

Vegetable pulp	Color of neat juice	Color of dough	Color of product baked
Water	Colorless	Milky	Center was milky, surface was brown
Spinach	Green	Green	Center was milky, surface was gray
Cucumber	Bright green	Light green	Center was light green, surface was gray
Celery	Green	Green	Center was green, surface was gray
Carrot	Orange	Light orange	Center was bright yellow, surface was golden reddish brown
Pumpkin	Yellow	Light yellow	Center was yellow, surface was golden yellow
Sweet potato	Light yellow	Light yellow	Center was light yellow, surface was golden yellow

Table 2: Influence of vegetable pretreatment time on beating effect\*

Pretreatment time	State of raw material	Beating results
0	No change	Each vegetable pulp was not delicate, beating was hard, residues was more
2	Vegetables were full and opaque	Beating of carrot was difficult; pumpkin and sweet potato were slightly more delicate than the pre-cooked; residues was fewer
3	Vegetables were full; pumpkin was translucent Surface of carrots and sweet potatoes were translucent	Beating of pumpkin was easy, pulp was delicate with a little residue; beating of carrot was difficult with much residue; beating of sweet potato was a little easy
4	Pumpkin became soft and rot, pre-boiled water of pumpkin became cloudy; sweet potato became translucent	Beating of pumpkin and sweet potato was easier with delicate pulp and a little long fibrous residue
5	Sweet potato became soft and rot, pre-boiled water of sweet potato became cloudy; carrots became translucent	Beating of three kinds of vegetables was easy with little residue

\*: Pretreatment time of carrots, pumpkin and sweet potatoes was the same

Table 3: Sensory evaluation of mixed vegetable pulp with different proportion\*

Ratio of pumpkin, carrot and sweet potato	Color evaluation	Flavor evaluation
1:1:1	4.8	4.7
1:1:2	4.7	4.8
1:2:1	4.9	3.0
2:1:1	4.8	4.8
1:2:3	4.5	4.5
1:3:2	4.9	3.5
2:3:1	4.8	3.0
3:2:1	4.7	4.5

\*: Both color evaluation and flavor evaluation included 3 choices: the liked, ordinary and disliked. Score of the liked, ordinary and disliked were 4~5 points, 3~4 points and 1~3 points, respectively

performance of 4 kinds of bread dough were compared. Comparing results were listed in Table 4.

It was seen from Table 4 that the dough quality was affected obviously by the sweet potato pulp with larger high starch content. When sweet potato pulp content was too high, bread dough could not extend fully, dough extensibility and toughness reduced. So, taste and volume of final bread was affected by the high sweet potato pulp content.

**Proportion determining of multiple vegetable pulps complex:** It can be seen from Table 3 and 4 that the relative high carrots content and reduce the flavor of mixed vegetable pulps, high sweet potato ratio can reduce the process properties of the dough. So, the carrots pulp content and sweet potatoes content should

be roughly equal. No.1, No.2 and No. 3 dough were produced with mixed vegetable pulp which ratio of pumpkin pulp, carrot pulp and sweet potato pulp were 1:1:1, 2:1:1 and 3:2:1, respectively. Color, extension, sticky elasticity and toughness three dough samples were compared with a blank as control. Except the blank, process performance of the other three dough samples were roughly the same. On the other hand,

flavor evaluation score of No.2 sample was highest in 3 dough samples. So that ratio of multiple composite vegetables was determined as that pumpkin pulp: carrot pulp: sweet potato pulp = 2:1:1.

**Determining of the dosage of multiple vegetable**

**pulps:** Multiple composite vegetables which ratio of pumpkin pulp, carrot pulp and sweet potato pulp was 2:1:1 was instead of 0, 25, 50, 75, 100% water in the original formula of common sweet bread to make different dough. Dough properties, fermentation process and finished product quality evaluation results of different dough were compared. The experimental results were shown in the Table 5.

It was seen from Table 5 that longer dough full extension time was required with the increase of the dosage of mixed vegetable pulp. When 75% of the water was replaced by multiple vegetable, pulp bread dough quality decreased, so the quality of bread was affected. When 50% of the water was replaced,

Table 4: Influence of vegetable pulp complex on dough performance\*

Vegetable pulp	Formation time (minutes)	Extension degree	Viscoelasticity	Toughness
Water	15	Extension was full; Dough can be pulled to translucent film	Smooth, soft and elastic	Good extensibility and toughness
Pumpkin Pulp	17	Extension was relatively sufficient; dough can be pulled to translucent film with regular circular hole	Soft and elastic and slightly sticky	Good extensibility and toughness
Sweet potato Pulp	20	Extension was inadequate, dough can not be pulled to translucent film	Sticky, elasticity is a bit poor	Certain extensibility and toughness
Carrot pulp	16	Extension was full; Dough can be pulled to translucent film	Smooth, soft and elastic	Good extensibility and toughness

\*: Moisture content was that pumpkin pulp was 85%; sweet potato was 80%; carrot was 90%

Table 5: Influence of dosage of multiple vegetable pulps\*

Dosage of vegetable pulp	Formation time (min)	Gluten extension degree	Dough viscoelasticity and toughness	Dough maturity (120 min)	Sensory evaluation score
0	15	Extension was full; dough can be pulled to translucent film	Smooth, soft and elastic, dough had good extensibility and toughness	Volume was 2.5 to 3 times the original; fermentation maturity was suitable	50
25%	16	Extension was full; dough can be pulled to translucent film	Smooth, soft and elastic, dough had good extensibility and toughness	Volume was 2.5 to 3 times the original; fermentation maturity was suitable	50
50%	18	Extension was full; dough can be pulled to translucent film	Smooth, soft and elastic, dough had good extensibility and toughness	Volume was 2.5 to 3 times the original; fermentation maturity was slightly less	49
75%	20	Extension as inadequate, dough can not be pulled to translucent film	Sticky, elasticity is a bit poor	Volume was 2 times the original; fermentation maturity was less	40
100%	More than 20	Extension was inadequate, dough can not be pulled to translucent film, easy to break	Sticky, elasticity is t poor, easy to break	Dough surface is not smooth, fermentation maturity was less	33

\*: Moisture of complex vegetable pulp which ratio of pumpkin pulp, carrot pulp and sweet potato pulp was 2:1:1 was 85%

fermentation time was slightly extended. Dosage of multiple vegetable in the dough should be as much as possible, so the dosage was fixed as 50%. According to weight ratio of water and flour in the original formulation as well as 85% moisture of vegetable pulp, it was calculated that the optimal dosage of composite vegetable pulp was 32.5% of the flour weight.

### CONCLUSION

A variety of vegetables that were pulped were added to bread dough according to certain proportion. The color of the finished bread product which was produced from dough containing different color vegetables pulp was compared, Carrots, pumpkins, squash and sweet potatoes were selected as main raw vegetable materials of nutrient bread.

It was determined that the optimal pre-cooking time before beating of pumpkin, sweet potatoes and carrots was 3 min, 4 min and 5 min from comparing beating results.

The process quality of bread dough added different dosage of vegetable pulp and the flavor of finished bread product containing different dosage of vegetable pulp was studied. The optimal weight ratio of pumpkin pulp, carrot pulp and sweet potato pulp was 2:1:1.

The optimal formula of nutrient bread composite of multiple vegetable pulp was that bread flour was 100 parts, water was 27.5 parts, multiple vegetable pulp was 32.5 parts (moisture of vegetable pulp was 85%), instant active dry yeast was 1 part, salt was 0.5 parts, white sugar was 15 parts, butter was 5 parts, eggs was 5 parts, milk was 4 parts, bread improver was 0.2 parts.

### ACKNOWLEDGMENT

This study was supported by spark plan project in Shandong province (No. 2011XH06006) and Science and technology development project in Weifang city (No. 20121333).

### REFERENCES

- Dnasby, M.A. and A.C. Bovell-Benjain, 2003. Sensory characterization of a ready-to-eat sweetpotato breakfast cereal by descriptive analysis. *Food Sci.*, 68(2): 706-709.
- Gao, X.L., Z.J. Fan and H. Zhang, 2013. Development of sweet potato cake. *Farm Mach.*, 55(6): 44-47.
- Guarda, A., C.M. Rosell, C. Benedito and M.J. Galotto, 2004. Different hydrocolloids as bread improvers and antistaling agents. *Food Hydrocolloid.*, 18: 241-247.
- Li, C.W., 2010. Research of sweet potato bread. *Food Process.*, 35(5): 82-83.
- Wang, Y.J., F.G. Xiao and C. Huang, 2012. Study on cake containing sweet potato dietary fiber. *Farm Mach.*, 54(5): 80-82.
- Zhang, L.F., 2009. Development of the bread with pumpkin. *J. Anhui Agr. Sci.*, 37(36): 18147-18148.
- Zhang, Z.Q., X.S. Guan, J. Wan *et al.*, 2011. Studies on the optimization of dietary fiber extraction from sweet potato residue and the effect on bread properties. *Food Sci. Technol.*, 48(10): 32-35.