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Development of Frozen Hash Brown from Hanatee Sweet Cassava

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ABSTRACT

This study is to develop the frozen hash brown (FHB) product from Thai sweet cassava, Hanatee (5M) by using the two cooking methods; boiling (B) and steaming (S). Next, the products were determined by comparing with a commercial hash brown (CHB1). Our findings revealed that the steaming (5MS) can give a better yield than the boiling method (5MB). The characteristic of 5MS was also relatively closed to the CHB1 that contained the hardness of crust (88.58-88.91 g), crispiness (1.69-1.99 mm) and hardness of crumb (19.16-23.76 g). In addition, this method revealed the lower brightness than boiling method (p<0.05) but higher than CHB1 (p<0.05). Finally, to compare between CHB1 and 5MS based on the Hedonic scale and Just about right (JAR) scales, there was no significantly difference of 5MS from CHB1 based on color, texture, flavor and oily (p>0.05). Although CHB1 gave crispiness of crust and fibrous better than 5MS, tasters preferred less salty of 5MS than CHB1. Furthermore, oily amount of 5MS (64%) provided better results than CHB1 (46%), and the suggestion of the 5MS should be improved in color, crust, texture, and fibrous.

Keywords: Frozen hash brown, Sweet cassava, Sensory evaluation, Physical characteristic

INTRODUCTION

Cassava (*Manihot esculenta Crantz*) is classified into two categories, bitter and sweet. Bitter cassava contains high hydrocyanic acid and bitter taste which is not common for human consumption. It has been widely used in animal feed and various industries such as starch, flour and industrial biomass (Ayetigbo et al., 2018) and the price is relatively cheaper than sweet variety in 10 times. Alternatively, sweet cassava contains a low hydrocyanic acid and less bitter taste. Namely, Hanatee is famous variety of sweet cassava in Thailand but it is still a small use for human consumption. It has been used for simple boiling, grilling, or simmering in syrup. Since Hanatee was considered to be a short-lived cassava (Oyeyinka et al., 2019), the use of sweet cassava as main ingredient need to be concerned the freshness and loss during harvesting.

Hash brown is one of frozen ready meals which is popular in North America, Europe and Asia Pacific regions (Mintel GNPD., 2019). Generally, hash brown made from potato and seasoning then deep fried. It usually knows as a staple breakfast food, side dish or one kind of essential snack food in people's leisure time (Yang *et al*., 2015). There were some reports about hash brown produced from fresh cassava. Somendrika *et al*. (2018) reported that the boiling method at 20 minutes showed a good texture and sensory of the hash brown using the fresh cassava MU 51 variety. This is suggesting the cooking method and suitable time are important factors for making hash brown.

This research was to develop the hash brown from Hanatee sweet cassava which is investigated by using the two cooking methods; boiling and streaming. Firstly, the recipe of hash brown was carried out and the products were then compared to commercial hash brown. Next the over all of characteristics was determined and discussed. Since the hash brown is an option for a convenient breakfast, it could be increased a consumption of sweet cassava which is not only for value added on sweet cassava products but also for support farmers who are growing sweet cassava in Thailand.

MATERIALS AND METHODS

Materials

Thai sweet cassava, Hanatee (5M) was used in this experiment. It has been cultivated and harvested (11 months) from Kanchanaburi province, Thailand. The ingredients of the hash brown are available from the local supermarket.

Selection of the commercial hash brown

The different potato commercial hash brown (CHB) were purchased from frozen food section of supermarkets around Bangkok. The five brands of frozen hash brown were selected based on size and shape. Then they were tested by survey with 50 consumers. The score including appearance, color, crispy of crust, texture, flavor, salty, oily and overall liking was marked by using hedonic scale from 1 to 9 (from 1 "dislike extremely" to 9 "like extremely"). The best acceptable commercial hash brown was selected to further studies.

Selection of Hash brown basic recipes

Four hash brown basic recipes were selected from U.S patent (Willard, 1989), cook book (Denny, 2005: The Culinary Institute of America, 2006) and hash brown recipes online (Milagros, 2018). The cooking process from Vahlsing (1971), Anderson (1981) and Galland (1986) were chosen to be used in this study and modified by researcher as follows. Firstly, potato was washed, peeled and diced and then cooking at 100°C after that soaked in water and drained. The diced potato was mixed with ingredients and press into mold of hash brown and keep at -18°C in blast freezer for 2 hours. After that, coating with fine bread crumbs and deep frying in 180°C using palm oil and storing in -18°C frozen storage until use. To analyze, the frozen hash browns were thawed at room temperature for 10 minutes before deep frying in 180°C palm oil as see in Figure 1. The selected recipe was determined by sensory evaluation using nine points hedonic scale (from 1 "dislike extremely" to 9 "link extremely"). It noted that hash brown basic recipes selection was done separately.
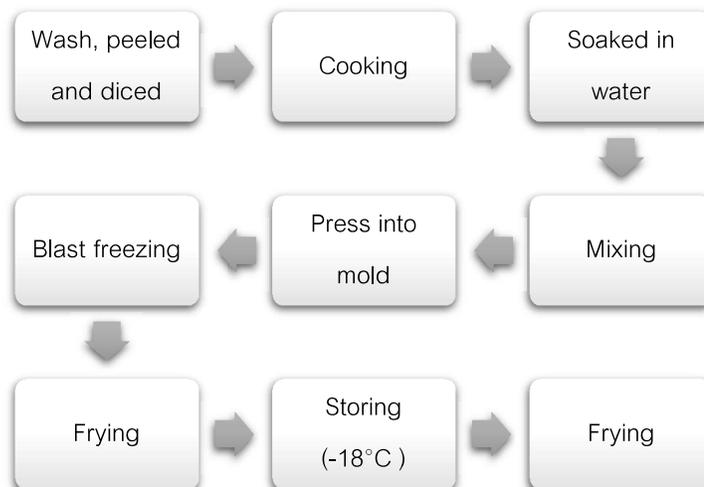
Figure 1. Hash brown cooking process was modified from Vahlsing (1971),
Anderson (1981) and Galland (1986).

The effect of cooking method on Hash brown from Hanatee sweet cassava

Hanatee sweet cassava was cooked followed by the selected hash brown basic recipe (Figure 1) using the boiling method, B (5MB) and steaming method, S (5MS) (inside temperature around 81-85 °C)

Sensory evaluation: The sensory evaluation of hash brown from Hanatee sweet cassava, using boiling and steaming was compared with the commercial hash brown. A quantitative descriptive analysis (QDA) sensory was evaluated with 15-point scale from 11 trained sensory panelists. Color, crispy of crust, texture, flavor, salty and oily were determined to consider for suit cooking method of Hanatee hash brown production.

Color and Texture: The external color of hash brown from Hanatee sweet cassava and commercial hash brown were measured after final cooking by deep frying. The results were showed with the CIELAB parameter (L*, a*, b*). The analysis was done in seven replicates. The texture of hash brown was performed with a TA-XT plus Texture Analysis modified from Albert *et al.*, (2009). The samples were measured with a cylinder probe (P/2), test settings were: pretest speed 5 mm/sec, test speed 2 mm./sec., posttest speed 5 mm./sec. and trigger force 5 g. The cylinder probe was applied distance 7 mm. deep

from hash brown surface obtained from various samples. The following parameters were measured: hardness of crust (g), crispiness (mm) and hardness of crumb (g). All texture analysis was done in fifteen replications per sample.

A sensory evaluation and Just about right scale (JAR) of hash brown from Hanatee sweet cassava compare with commercial hash brown

Finally, the best cooking method of hash brown from Hanatee sweet cassava was selected to compare with commercial hash brown using 9 points hedonic scale combining with Just About Right (JAR) 5-points scale (Too strong, Strong, Just-right, Weak, Too weak) judged by 11 trained sensory panelists to look for trend and opportunity for improvement. This study used Just About Right criteria set developed by Somsiri and Sujinda (2012) to interpret the result.

To interpreted the result, we looked first at the Just-right score, if the Just-right score was higher than 70%, there would be no need for improvement. Conversely, if the score was lower than 70%, it indicated a need for improvement. Then, to evaluate a direction for improvement, we reviewed the rest of score in either on weak side (Weak and Too weak) or on strong side (Strong and Too strong) or on both sides. If the directions of score gone to either on weak side or strong side only, it indicated that we would needed to make an improvement in that particular direction. However, if the rest of score appeared on both sides, we needed to subtract the low score on one side from the high score on the other side. If the answer from subtraction less than 20%, just ignore it, there was no significant need for improvement. On the other hand, if the answer from subtraction higher than 20%, the improvement would need on the high score side. (Figure 2)
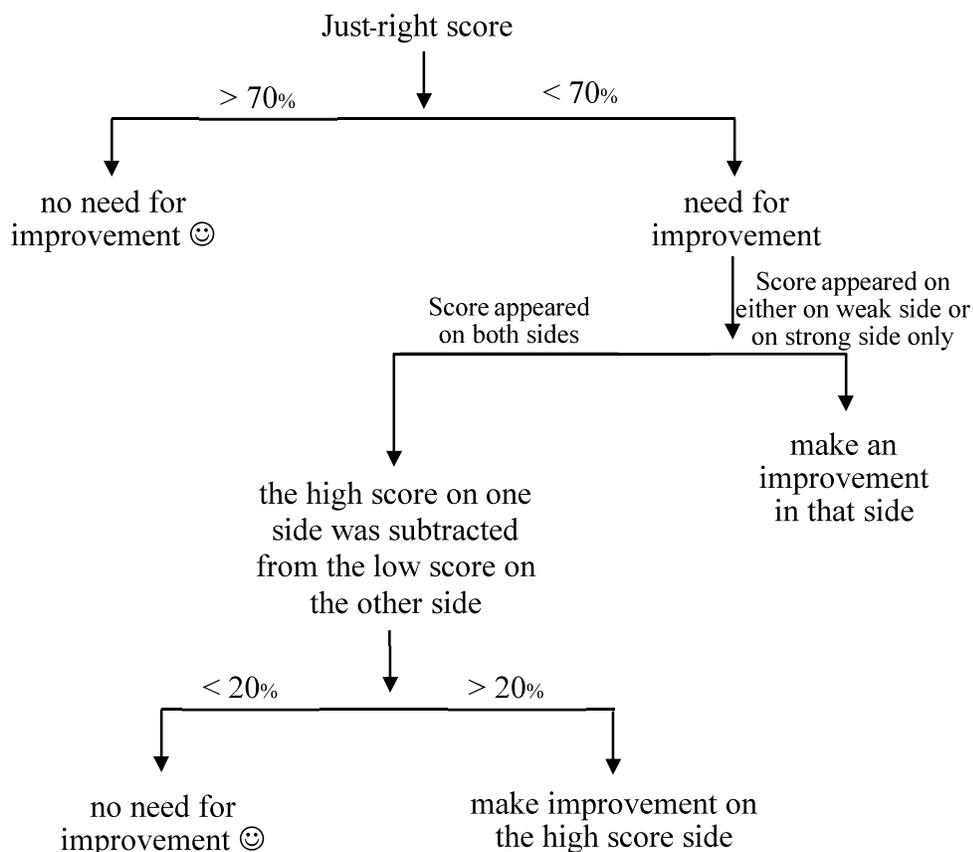
Just-right score

> 70%   < 70%

no need for
improvement ☺

need for
improvement

Score appeared on
either on weak side or
on strong side only

Score appeared
on both sides

the high score on one
side was subtracted
from the low score on
the other side

make an
improvement
in that side

< 20%   > 20%

no need for
improvement ☺

make improvement on
the high score side

Figure 2. Just about right (JAR) Result Interpretation Steps

Statistical analysis

The selected commercial hash brown and the effect of cooking method on Hash brown from Hanatee sweet cassava were analyzed using variance (ANOVA). The statistical analysis was used Duncan's multiple range test ($P<0.05$). Sensory evaluation and Just about right scale (JAR) of HB and CHB was determined by t-test. All statistical analyses were performed using IBM SPSS trial.

RESULTS AND DISCUSSION

Selection of the commercial hash brown

The five brands of commercial hash browns (CHB1, CHB2, CHB3, CHB4 and CHB5) were selected and evaluated by sensory tests. The flavor liking of these brands was not significantly different (p>0.05). Appearance, texture and overall liking of CHB1 (small cylinder), CHB2 (triangle thick flat) and CHB4 (oval flat shape) were more acceptance than CHB3 (rectangle flat) and CHB5 (rectangle flat) (Figure 3). These suggested that consumers prefer the small size rather than large pieces. CHB 1 showed higher preference scores of the crust, salty and oily, compare to the CHB2 and CHB4 (See in Table 1). CHB1 was in small shape, crispy crust and less oil absorption, therefore, it was selected to be used as commercial hash brown in this study. In addition, a circular hash brown shape with a diameter of about 4 cm is another preference from the consumer.

| CHB1 | CHB2 | CHB3 | CHB4 | CHB5 |

Figure 3. Different shape of five brands commercial hash browns

Table 1. Sensory scores of 5 commercial hash browns

Physical characteristic	Sensory scores				
	CHB 1	**CHB 2**	**CHB 3**	**CHB 4**	**CHB 5**
Appearance	6.76 ± 1.57^{ab}	7.06 ± 1.16^{ab}	6.57 ± 1.52^{bc}	7.26 ± 1.12^{a}	6.17 ± 1.58^{c}
Color	6.74 ± 1.42^{b}	7.22 ± 1.31^{ab}	7.00 ± 1.30^{b}	7.61 ± 0.98^{a}	6.00 ± 1.49^{c}
Crispy of crust	7.65 ± 1.26^{a}	6.91 ± 1.20^{b}	7.00 ± 1.30^{b}	7.31 ± 1.33^{ab}	6.94 ± 1.38^{b}
Texture	6.74 ± 1.51^{a}	6.41 ± 1.67^{ab}	6.20 ± 1.28^{ab}	6.46 ± 1.56^{ab}	5.98 ± 1.70^{b}
Flavor[ns]	6.70 ± 1.57	6.65 ± 1.51	6.19 ± 1.40	6.74 ± 1.38	6.33 ± 1.48
Salty	5.91 ± 1.56^{ab}	6.52 ± 1.40^{a}	5.80 ± 1.57^{b}	5.80 ± 1.82^{b}	6.33 ± 1.49^{ab}
Oily	6.43 ± 1.35^{a}	5.69 ± 1.85^{b}	4.91 ± 1.92^{cd}	5.46 ± 1.70^{bc}	4.43 ± 1.90^{d}
Overall liking	7.00 ± 1.18^{a}	6.67 ± 1.26^{ab}	6.28 ± 1.20^{b}	7.00 ± 0.99^{a}	6.17 ± 1.66^{b}

a,b... means within a row with different letter are significantly different (p<0.05)
ns Not significant (p>0.05)

Selection of Hash brown basic recipes

Four basic hash brown recipes were selected from U.S patent (Willard, 1989), cook book (Denny, 2005: The Culinary Institute of America, 2006) and hash brown recipes online (Milagros, 2018). Each recipe has difference in ingredients and quantities. All the sensory tests revealed that the best acceptable hash brown recipe is consisted of potato, salt, pepper, flour, egg and butter.

The effect of cooking method on Hash brown from Hanatee sweet cassava

There was no different in intensity of color between boiling method (5MB) and steaming method (5MS) when compared to CHB1 (Figure 4). In addition, CHB1 showed the lowest of brightness (L*) when measured by colorimeter (Table 2). This explains that the potato has more yellowish color than cassava. The steaming method (5MS) gave a brightness lower than the boiling method (5MB) because it can prevent heat direct to cassava skin that is not effect on the cassava skin. So cassava was prepared from the boiling method that directly contacted with boiling water and dissolve the colorant of skin. So the color was brighter than cassava from streaming method.
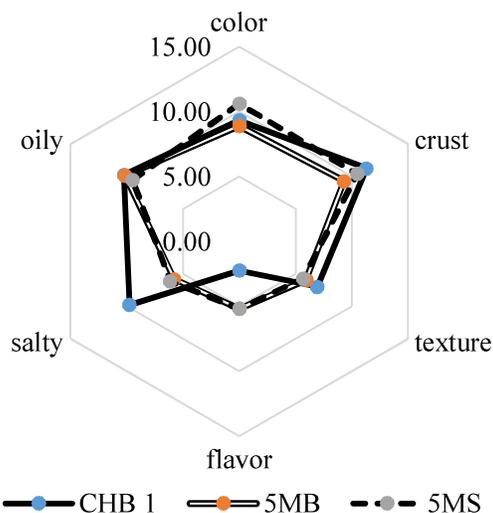

Figure 4. Web diagram of mean values of sensory characteristics (QDA)

between Hanatee hash brown (5MB and 5MS) compare with CHB1

Table 2. Physical properties of CHB1 and Hanatee hash brown with different cooking methods

Physical properties	CHB 1	5MB	5MS
Color			
L*	43.25 ± 0.91^c	53.50 ± 0.13^a	49.77 ± 0.88^b
a*	7.00 ± 0.35^{ab}	4.35 ± 0.86^b	7.96 ± 1.29^a
b*	30.76 ± 0.27^{ab}	29.80 ± 0.48^b	30.92 ± 0.1^a
Texture			
Hardness of crust (g.)	130.92 ± 2.41^a	88.91 ± 2.16^b	88.58 ± 0.03^b
Crispiness (mm.)^{ns}	1.38 ± 0.57	1.69 ± 0.25	1.99 ± 0.36
Hardness of crumb(g.)	26.39 ± 2.00^a	23.76 ± 2.85^{ab}	19.16 ± 0.88^{ab}

a,b... means within a row with different letter are significantly different (p<0.05)
ns = Not significant (p>0.05)

According to score of a crispy of crust, the CHB1 showed the highest which is no significant difference compare to Hanatee hash brown from steaming method (5MS) (Figure 4). Both 5MB and 5MS was not different in texture (p>0.05) (Table 2) and the hardness of crust in CHB1 showed higher than 5MB and 5MS, both 5MB and 5MS were no significant in the difference (p>0.05). For crispiness, no significant was found in both 5MB and 5MS (p>0.05) compare to CHB1. About flavor and salinity, CHB1 found to have more flavor from enhancer than the real flavor of the potato. Salty, CHB 1 showed higher salinity than all samples of 5M. For oiliness, all samples of 5M were not significantly different from CHB1 (Figure 4). In conclusion, 5MS contains the good results in color and crispy of crust then 5MS would consider be used to further optimize.

A sensory evaluation and Just about right scale (JAR) of hash brown from Hanatee sweet cassava compare with commercial hash brown

Hanatee prepared from steaming method (5MS) and commercial hash brown (CHB1) were tested with sensory preference and liking. There were no significantly difference (p>0.05) among color, texture, flavor and oiliness. CHB1 had liking score of crispy of crust higher than 5MS (Table3). According with hardness of crust which found that CHB1 had a hardness of crust at 130.92 g. higher than 88.58 g. of 5MS (see in Table 2).

For Fibrous, CHB1 and 5MS were shown significant in the difference ($p < 0.05$). The texture of 5MS have more fibrous than CHB1. Hanatee contain a high in fiber content that make a not much smooth texture and soft texture after cooking. In contrast, potato has a very smooth texture and less fiber, it received less preferable in texture.

For salty, testers gave score for 5MS better than CHB1 significantly because CHB1 has enhanced in seasoning by adding more salt for commercial purpose. On the other hand, 5MS was adding much less salt to enrich a natural favor of cassava. Therefore, testers gave much better preference score to 5MS than CHB1.

Table 3. Liking score of CHB 1 and 5MS

| Physical characteristic	CHB 1	5MS
Color[ns]	7.60±0.70	7.30±1.06
Crispiness of crust	8.50±0.71[a]	6.60±0.70[b]
Texture[ns]	7.40±1.07	6.60±0.70
Fibrous	7.50±1.08[a]	5.80±1.48[b]
Flavor[ns]	6.40±1.43	7.00±0.94
Salty	6.30±0.95[b]	7.40±0.84[a]
Oily[ns]	6.60±1.78	7.20±0.92

a,b... means within a row with different letter are significantly different ($p < 0.05$)
ns Not significant ($p > 0.05$)

CHB1 and 5MS were tested using Just About Right (JAR) method. This is to measure consumer requirements of a sensory characteristic to be used for further development and improvement.
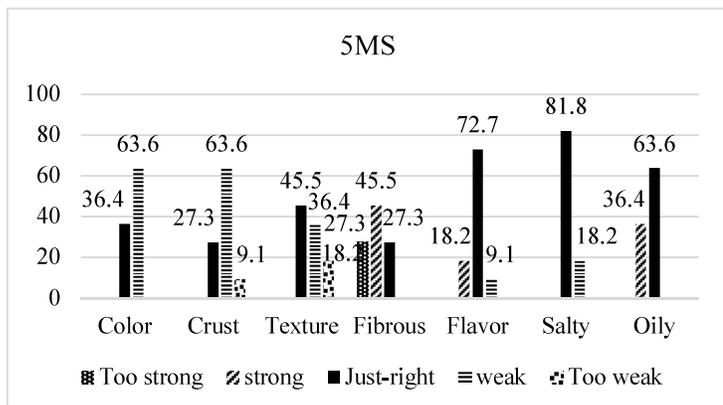
The characteristics of CHB1, color, crispy of crust, texture and fibrous had score higher than 70%. It indicated that there was no need for improvement in those sensory characteristics. Regarding to potato flavor, CHB1 revealed the score only around 36% to 18% range which were so weak. Because CHB1 appeared to have rich in flavoring and seasoning food additive, these ingredients affect to reduce potato natural flavor. Decreasing the amount extra flavoring or seasoning added is a concern to be improved. Like salty, most testers gave quite strong scoring (81 % to 18.2% range). CHB1 would need to reduce in salt. Concerning oil absorption, CHB1 received strong

(36.4%) and too strong (18.2%) score from testers. Thus, it would need to make CHB1 absorbing less oil. (Figure 5a)

The characteristics of 5MS, flavor and salty had score higher than 70%, so there was no need for improvement. But, it indicated that 5MS had weak in color (63.6%) and found weak and too weak in crispy of crust (63.6% to 9.1% range). Including the texture, that found weak and too weak (36.4% to 18.2% range). Because Hanatee flesh was softer and white color, it resulted quite weak in texture and color. So 5MS would need to improve color, crispy of crust and texture to be strong. Moreover, testers found more fibrous (45.4% to 27.3%) and more oil absorption (36.4%) in 5MS (Figure 5b). There was a need for improvement in those last two characteristics as well.
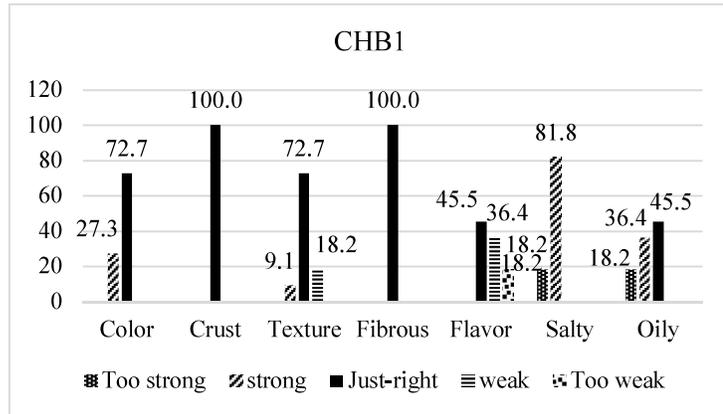
(a)

(b)

Figure 5. Just about right scale test. CHB 1 (a), and 5MS (b)

In comparison of characteristic between 5MS and CHB1, CHB1 has an attractive golden brown color, good crispy of crust outer, soft texture inside and still see the pieces of potatoes flesh inside. Because there was no fibrous and smooth texture on potato flesh, it was easy to orally consume than cassava meat (5MS) which had fibrous. Nevertheless, 5MS found to have better natural flavor, less flavoring and seasoning additives and also found to have less salty than CHB1. For oil absorption, we discovered that in 5MS gave higher Just About Right (JAR) score than CHB1.

CONCLUSION

In conclusion, this work is the first report to develop frozen hash brown using Thai sweet cassava, Hanatee. We found that streaming method can be used to prepare hash brown since it has been revealed better yield than boiling method and showed relatively closed to the commercial hash brown including the hardness of crust (88.58-88.91 g), crispiness (1.69-1.99 mm) and hardness of crumb (19.16-23.76 g). In addition, overall liking was no significantly difference of 5MS from CHB1 based on color, texture, flavor and oily (p>0.05). However, this product may have further improvement in certain attributes to consumer acceptance such as improved in color, crust, texture, and fibrous.

ACKNOWLEDGEMENTS

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