Scientific Research

QUALITY CHARACTERISTICS OF MODIFIED CASSAVA FLOUR (MOCAF) COOKIES INCORPORATED WITH CHICKEN MEAT AND CARROT PUREE AS NUTRITIOUS SNACK TOWARDS CHILDREN

Nur Aini Mahmudah[1*], Nur Agustin Mardiana[1], Aditya Wirawantoro Putra[1], Panji Purnomo[1], Anang Widigdyo[1], David Kurniawan[2]

[1]Department of Processing of Poultry Product, State Community College of Putra Sang Fajar, Blitar, Dr. Sutomo Street No. 29, Blitar, East Java 66133, Indonesia
[2]Department of Animal Science, Faculty of Animal Science, Universitas Brawijaya, Veteran Street No. 16A, Malang, East Java 65145, Indonesia

ARTICLE INFO	ABSTRACT
	The trend of snacking is accelerating over time, along with the fact that cookies are the most common and most consumed snack in the world. Particularly in children, snacking remarkably accounts for the total daily calorie intake. Mocaf (modified cassava flour) cookies incorporated with chicken meat and carrot puree at various levels [F1 = 0:0 (control), F2 = 12.5%:37.5%, F3 = 25%:25%, F4 = 37.5%:12.5%] were scrutinized for their physical properties, chemical composition, and sensory characteristics. This research used a completely randomized experimental design. These incorporations resulted in a significant lowering value (P<0.05) of fat content, ash, and calorie, whereas the hardness properties and moisture content were recorded to have increasing trend. The protein content and total dietary fiber of cookies which are considered substantially beneficial for health, were increased on treated cookies. The combination of chicken meat and carrot puree was found not to reduce the physical lightness (L*) and children panelists' preferences by color, aroma, and taste of treated cookies, compared to the control sample. All cookies formulations had good receptivity after sensory evaluation. It is important to maintain a palatable product for the development of nutritious cookies towards children.

1- Introduction

World Health Organization (WHO) unmasked the information about 149.2 million children under the age of 5 were suffering from stunting, whereas 45.4 million were underweight, meanwhile 38.9 million were dealing with overweight problem in 2020. Stunting is a condition that slows growth and development in children due to problems with nutrient absorption, growth hormones, and recurrent disease. The rate of stunted children under 5 years age in Indonesia by 2022 was 21.64% (1). Most countries have regulations to accelerate the reduction of stunting related to various fields, noting that later stunting will affect the quality of human resources in the future. The short-term impact of stunting is that the child's immune system will be weakened and more susceptible to disease, while in the long term will reduce cognitive and motoric development. The initial manifestation of stunted children is thin body and disproportionate height. In addition, underweight is also a problem for Indonesian children with the incidence continuing to increase every year (2). Adequate intake of food with various and balance diet can prevent children from health problem during growth period.

Consuming snacks enhances nutritional intake (3). The trend of snacking is increasing time by time. Data presented by Snack Food – Worldwide in 2022 showed that cookies and crackers are the most consumed snack with the amount of revenue 231.60 billion USD in 2020, 247 billion USD in 2021, and 264.80 billion USD 2022 (4). Wheat flour is the main raw material to produce cookies, that being a problem for Indonesia since it is fully imported. Indonesia Feed and Grain Update (2022) showed information about wheat imports from 2021 to 2022 was raised (5), which reflects higher need and demand for production of food comprised on wheat flour. Wheat substitution for snack production by using local flour commodities at a relatively cheap price is considerably necessary to produce new valuable products and nutritious cookies.

Modified cassava flour (mocaf) is used as alternative substitute for cookies making to reduce wheat flour dependency in Indonesia(6), with its properties that is resemble to the wheat flour. Mocaf flour has moisture content 11.90%, protein 1.2%, ash 1.30%, carbohydrate 85%, fat 0.6%, and dietary fiber as much as 6%, higher than wheat flour (0.3%). Mocaf utilization did not reduce the acceptability of the color, flavor, and aroma on butter cookies, meaning that the products were favorable by consumers (7). Regarding the lower protein content, addition of protein materials in the cookies is important to enhance the nutritional value. The animal proteins source are appraised to be combined to cookies production, due to their higher digestibility and complete essential amino acid than plant-based proteins (8).

Chicken meat is one of the accessible and affordable poultry considered as high-quality protein (30.9%) and other nutrients that are necessary for legitimate body metabolism (9). Chicken meat its derivative products are generally favoured and the expenditure continues to develop in various countries. An investigation of wheat cookies product with incorporation of chicken minced meat up to 20%, exposed that the taste score and overall acceptability were increased after (10).

To comply with the mocaf and chicken meat ingredients, inclusion of vegetable as source of vitamin, minerals, and antioxidant can intensify more the nutritional value of cookies. Carrot being an important root vegetable for its abundant antioxidant compounds such as xanthophylls, carotenoids, phenolic compounds, vitamin A, B1, B2, C, E, folic acid, flavonoids, and even pectin as fiber source (11) (12). The carrot (*Daucus carota*) is a major source of ß-carotene, the carotenoid with the most efficient biological yield of vitamin A and several other functional components having significant health-promoting properties (13).

Vitamin A could reduce the risk of stunting in children under five, along with adequacy levels of zinc and iron (14). Carotenoids (lutein, zeaxanthin) act as a protective shield (improving) the eyesight (15), and this is matching with the habit of children in this century that is having more time on gadget utilization and may lead into eyes fatigue. This paper presenting about characterization of cookies product composed of mocaf flour incorporated with chicken meat and carrot puree by physical quality, nutritional value, and sensory properties towards children.

2-Materials and methods

2.1. Biomaterials and chemicals

Modified cassava (mocaf) flour was brought from Yogyakarta, Indonesia. The chicken meat, carrots, and all other ingredients which include sugar, salt, butter, baking powder were obtained from Blitar City, East Java. The chemicals used included H_2SO_4 (Emsure), Kjeldahl powder, HCl (Sigma), NaOH (Merck), Alcohol 96% (Mercks), K_2SO_4 (Sigma), N-Hexane (Emsure), and distilled water.

2.2. Preparation of sample

Chicken fillets were washed, drained, and steamed for 30 mins until a compact texture was obtained. The cooked chicken meat was then cooled and ground by using a food processor (Philip HR-7310) for size reduction. The minced chicken meat was stored in a tight polyethylene pouch packaging and kept in the freezer chamber with a temperature of -18°C prior to cookies production. For the carrot preparation, it was cleanly peeled, washed, and cut into 2 cm long before blanched for 2 minutes in boiling water. The carrots were crushed with a blender (Philips HR-2115), without the addition of water, until a thick puree texture was obtained.

The cookies making was initiated by mixing the beaten egg and sugar as much as written in formulation (Table 1) until mixture has thickened and turned a very pale yellow. The salt, baking powder, and butter were alternately added. The carrot puree was gradually added into the mixture, the cooked chicken meat, and mocaf flour after. The dough was homogenized evenly. The cookie dough was then printed on a baking sheet that had been lined with food paper. Cookies were cooked in the oven (Modena BO-2664) at 170ºC for 30 minutes. Then, the cooked cookies were removed, allowed to cool, and stored in aluminum foil pouches before being tested for physical, chemical, and sensory quality. The formulation of mocaf cookies incorporated with chicken meat–carrot puree was presented in Table 1. The ratio of chicken meat:carrot was at 4 levels which included: F1 = 0:0 (control), F2 = 12.5%:37.5%, F3 = 25%:25%, F4 = 37.5%:12.5%.

Table 1. Formulation of cookies

Ingredient (g)	F1	F2	F3	F4
Mocaf flour	200	200	200	200
Cooked chicken meat	0	25	50	75
Carrot puree	0	75	50	25
Butter	120	120	120	120
Egg	120	120	120	120
Salt	8	8	8	8
Sugar	50	50	50	50

Baking powder	2	2	2	2

2.3 Quality assessment

2.3.2. Determination of physical properties

Chromameter instrument was used for physical color measurement of cookies (Konika Minolta CR 400). The color of the cookies was analyzed using CIE L*-a*-b* system. The a* result with positive values declare for reddish colors and negative values for greenish ones. b* result with positive values signify yellowish colors impression and negative values for the bluish ones. L* is luminosity level from 0-100. The lower score of L*, the darker a food product mark. The higher score of L*, the lighter food samples color (16) (17).

The textural properties of cookies were measured using a Texture Analyzer (TA-XT2i, Stable Micro Systems, Godalming, UK). The samples were put on the base, and their hardness, springiness and chewiness were measured using a flat cylindrical probe (P/36 R, 2 cm in diameter). The pre-test, test and post-test speeds were set at 2.0, 1.0 and 1.0 mm/s, respectively, with the compression distance being 5 mm, essentially full compression. The hardness (as the fracture force) of cookies was set at a trigger force of 25 g using a load cell of 50 kg and was the maximum value of the force (g) at the cookies breaking point (18).

The cookies textural properties were calculated utilizing a Texture Analyzer instrument (TA-XT2). Hardness, fracturability, gumminess, and chewiness were estimated utilizing a testing cylindrical probe (P/36 R, 2 cm). The pre-test speed was at 2.10 mm/s, test speed was 1.0 mm/s, and post-test speed was 1.0 mm/s. The pressure distance was 5 mm. Hardness counted as mechanical penetration power was set at a force of 25 g and load cell of 50 kg.

2.3.1. Determination of chemical properties

The content of moisture, ash, protein, and fat in cookies products were determined by using the AOAC method (19). Total dietary fiber content (TDF) was measured according to the gravimetric method. The total carbohydrate content was calculated with the method of 'by difference'. Data obtained were expressed as g/100 g on wet basis. Total energy was calculated with factors of conversion valued: carbohydrates $\rightarrow$ 4 kcal/g, proteins $\rightarrow$ 4 kcal/g for, and lipids $\rightarrow$ 9 kcal/g.

2.3.1. Determination of sensory properties

A total of 25 children aged 3-9 years were asked to evaluate the color appearance, aroma of cookies, taste, and texture of product. The respondents were provided with four cookies samples. Each panelist accompanied by their parents to assess the cookies quality, followed by a brief instruction and also informed consent that was explained prior to evaluation. A glass of water was given to the children panelist for neutralize the mouth after tasting each sample. Each sensory attribute was rated based on the principle of the hedonic test, by using a scoring system (1$\rightarrow$ dislike very much, 2$\rightarrow$ dislike, 3$\rightarrow$ neutral, 4$\rightarrow$ like, 5$\rightarrow$ like very much). The assessment form is equipped with smiley emoticons on each scoring level to help illustrate children about the impression after evaluating cookies.

2.4. Statistical analysis

All samples were run in triplicates. The data were expressed as mean ± standard of deviation. Variation of data were analyzed using one-way analysis of variance (ANOVA) by Minitab 18 (Minitab LLC, Pennsylvania), followed with Duncan's multiple-range test to separate means value. The significance was analyzed at the level of 0.05 (p < 0.05) between samples.

3-Results and Discussions

3.1.Physical Quality of Cookies

Quality of food is determined by many features. Appearance is the very first factor caught by consumer to evaluate the quality of food products. The appearance of a food as depicted by its color has been displayed to impact the loveliness and agreeableness of purchasing willingness, which is then marked as a quality attribute. The color appearance of cookies was evaluated by L*, a*, and b* parameters. The L* value scale is from 0 to 100. The higher score, the lighter color, meanwhile the lower score indicating darker color. No significant difference found in all four cookies samples by L* value, meaning that addition of chicken meat and carrot puree up to highest percentage had no effect on the cookies lightness. The L* value from all samples ranged

from 60.45-62.96 (Table 2). This result was higher than lightness of cookies product made from mocaf combined with soybean flour, which ranged from 45.46 – 55.08 (20).

The a* parameter which measures redness, showed a significant difference from cookies samples with positive (+) values. The b* parameter that measures blue-yellow impression, showed significant difference with positive (+) values. The positive a* and b* had meaning that all cookies given reddish-yellowish impression, as it possibly caused by the addition of carrot puree that brought up carotene pigment. In a research, it was revealed that total carotenoid showed positive correlations with b* value in the pumpkin byproduct after drying (21). Both results above indicated carotenoids might appropriately determine the yellowish color on food product.

Table 2. Physical quality of cookies

Parameters	F1	F2	F3	F4
L*	60.45 ± 2.17 a	62.85 ± 2.37a	62.53 ± 2.28	62.96 ± 0.74a
a*	7.03 ± 0.74ab	6.00 ± 0.39b	7.89 ± 0.05a	7.04 ± 1.80ab
b*	34.37 ± 0.43ab	34.37 ± 0.64b	34.20 ± 1.44ab	35.10 ± 0.70a
Hardness (N)	95.87 ± 2.35d	479.3± 69.4a	275.2 ± 40.2c	353.1 ± 18.4b
Fracture (N)	2.71 ± 0.55a	3.32 ± 2.09a	3.75 ± 1.83a	7.37 ± 4.88a

Expressed values were mean±SD (n = 3); a same rows containing means with the same superscript letters are not significantly different (p < 0.05).

Cookies texture belongs to the critical quality parameters for consumer approval (22). For children age and adolescents, texture is a major attribute of food influencing preferences. In children, tendencies to like and dislike towards food textures are related to the development of oral function on chewing and digesting. Textures that are challenging to bite at a certain time of physical growth are usually denied (23). Physical texture properties of cookies were evaluated from aspects of hardness, fracturability, gumminess, chewiness, cohesiveness, and adhesiveness.

Hardness describes the force to compress food. In sensory analysis, hardness is the force required to bite cookies. Hardness score of all four cookies samples was significantly different. F1 exhibited the lowest score (95.87 N) (Table 2), meaning that it had the minimum

energy to be deformed among four cookies, while F2 had the highest score (479.3 N). The increasing trend of cookies' hardness might cause by hydrogen bonding within the dough after the interaction of protein and starch (24).The highest value for hardness was on F2 with the highest amount of carrot puree addition. In accordance with Sahni and Shere, 2017, higher hardness values were attained with higher level of incorporation of carrot pulp paste powder into the dough, which might be ascribed in higher water content within cookies dough and resulte harder cookies.

Fracturability is a term to describe the ease with which the tested cookies crumble. Fracturability is considered an important indicator after hardness, to analyze food texture, especially in baked products such as bread and biscuits/cookies. These

characteristics need to be measured because they can affect the physical shape, texture, appearance, and organoleptic crispness of the resulting cookie products (25). In mocaf cookies, the higher fracturability force was noticed to be gradually increasing from F1- to F4 as the alteration of chicken meat and carrot puree composition. F1 was the most fracture cookies with the lowest force needed to make it crumble. This result is in line with the addition of clove powder and followed by inclining hardness and fracturability score of cookies (26). It could be referred to the impact of protein and fiber substances on the protein-carbohydrate network forming.

3.2. Chemical Composition of Cookies

The deliciousness, accessibility, durability, various flavors, and readily to eat,

cookies are the most consumed snack in vast amounts for all ages all over the world (27). Cookies are classified as an energy source since it usually made from wheat flour, oil, and sugar (28). The trend of snacking as part of children's meals is a growing global interest. It comes along with a pattern indicating a large increase in snacking consumption over recent decades. Snacking has a considerable impact on nutritional intake on children. The specific habit of snacking within children's diets may mitigate the occurrence of diseases caused by dietetic problem (29). Later, it has been understood that early childhood is a crucial period for promoting healthy eating habits (30), including snacking.

Table 3. Chemical composition of cookies

Parameters	F1 (control)	F2	F3	F4
Moisture content (%wb)	$4.32 \pm 0.09b$	$4.77 \pm 0.11a$	$4.33 \pm 0.03b$	$3.86 \pm 0.10c$
Ash (%wb)	$2.79 \pm 0.04a$	$2.50 \pm 0.07b$	$2.49 \pm 0.02b$	$2.59 \pm 0.10b$
Protein (%wb)	$4.91 \pm 0.06d$	$7.08 \pm 0.03c$	$8.24 \pm 0.07b$	$10.11 \pm 0.10a$
Fat (%wb)	$32.62 \pm 0.06a$	$29.75 \pm 0.14c$	$30.21 \pm 0.12b$	$30.24 \pm 0.14b$
Carbohydrate (%wb)	$45.67 \pm 0.29a$	$45.17 \pm 0.22a$	$42.70 \pm 0.37b$	$38.54 \pm 0.25c$
Energy (cal/100 g)	$491.99 \pm 1.62a$	$473.38 \pm 0.55b$	$473.07 \pm 0.79b$	$465.19 \pm 0.96c$
NSF (% wb)	$4.73 \pm 0.16d$	$5.22 \pm 0.03c$	$5.83 \pm 0.12b$	$7.15 \pm 0.05a$
SF (%wb)	$0.22 \pm 0.02c$	$0.30 \pm 0.00b$	$0.34 \pm 0.00a$	$0.36 \pm 0.00a$
TDF (%wb)	$4.95 \pm 0.15d$	$5.52 \pm 0.03c$	$6.18 \pm 0.12b$	$7.51 \pm 0.05a$

Expressed values were mean±SD (n = 3); a same rows containing means with the same superscript letters are not significantly different (p < 0.05).

In this paper, highest moisture content was on F2 cookies (Table 3), as influence of highest carrot puree (37.5%), which similar result was reported by carrot pomace-incorporated cookies (31). Higher carrot pure gives more moisture content within the dough and within the cookies after same baking time and temperature compared to the control (F1). Ash content was significantly highest on F1 (p < 0.05). This result denoted that the 100% mocaf flour in F1 formulation containing more mineral residue than other cookies with addition of chicken and carrot juice. Regarding the composition of cookies, mocaf flour has ash

content 1.35% (32), chicken meat 0.79% (33), and carrot has 1.33% (34).

The highest protein content of cookies was observed on F4 sample (Table 3), followed by the highest proportion of chicken meat addition. Addition of 75% chicken meat could contribute the protein increasement up to 105.91% than control sampel (F1). F2, F3, and F4 exhibited higher values than the minimum requirement of protein content on biscuit product (5%), established by Indonesian National Standard (SNI 2973:2011). Incorporation of chicken meat as animal protein source in cookies, not only enhances nutritional aspect, but also enrich the amino acid profile, and adds the sensory

quality profile. Later, it offers an alternative for chicken meat development product (35).

Addition of chicken meat and carrot puree did not increase the content of either fat or carbohydrate on mocaf cookies, compared to the control sample (Table 3). This was in contrast to previous research, that found out the enhancement of crude fat content on cookies with incorporation of 10% chicken meat mince from 22.52%. to 23.58% (10). On the other hand, due to the incorporation of carrot puree, this result was in line with the reduction content of fat on wheat cookies after supplementation of 15% carrot juice concentrate (11). The fat and carbohydrate content mainly contributes to the energy (calorie) of cookies. This product may provide the children consumer necessity for highly protein snack with sufficient fat and calorie content. Cookies are good transporter of dietary nutrition. Carbohydrate and fat sources can be fortified with protein by subsequently replacing wheat flour with protein substances to a satisfying and acceptable level (36).

The non-soluble fiber (NSF), soluble fiber (SF), and total dietary fiber (TDF) were recorded to rise, along the incorporation of chicken meat and carrot puree (Table 3). Both components have crude fiber around 1.08-1.22% (37) and 1.2-2.4% (38) respectively. This result was compliant with chicken biscuit incorporated with selected wheat bran had risen up its crude fiber content (39). Also, as well as in cookies incorporated with carrot pomace had the crude fiber content increased, compared to control cookies (40). The soluble fiber easily attracts water and forms into a gel-like substance in the large intestine, then it is digested by intestinal microflora. Hence, it produces some short-chain fatty acids and energy for colon microbes, and might give prebiotic effects, promoting growth and multiplying of good bacteria. Non-soluble fiber is acting as bulking agents, since it does not dissolve in water. It remains intact as food passes through the gastrointestinal tract and may improve bowel transit, preventing colonic infection and cancer by shorter transit time (41).

UK Scientific Advisory Committee on Nutrition (SACN) recommended a daily intake of fiber of 15 g/day for children aged 2–5 years, 20 g/day for those aged 5–11 years, 25 g/day for those aged 11–16 years and 30 g/day for those aged 16–18 years (42). The total dietary fiber on this mocaf cookies product had range of 4.95 - 7.51%, which consumption of 100 gr cookies may contribute to fulfilment of 24.7-37.5% daily fiber intake for children aged 5-11 years. Dietary fiber notably marked as essential food nutrient for the human diet. It provides certain physiological benefits through the fermentation of various gut microbes. The effect of consuming dietary fiber including cholesterol reduction, glycaemic, and weight maintenance. Fiber deficiency has been linked to several conditions in children such as constipation, irritable bowel syndrome, allergies, and immune-related disorders (43), but excessive fiber intake may lead to some symptoms of bloating and abdominal discomfort (41).

3.3. Sensory Properties of Cookies

The appearance, taste, aroma, and texture of food are parameters that make consumer decide the product to be interesting or unappetizing, stale, or even culturally inappropriate (Chambers, 2019). Of all cookies tested to the children panelist, no significant difference was found on the color appearance and aroma of mocaf cookies (Table 4). The color was rated between 3.60-3.80, meaning it was "liked" by panelists. Chicken meat and carrot puree did not affect panelists' preference for color feature (p<0.05). In relation to the lightness level by L* score (Table 1), the cookies were having negligible difference. One of the basic criteria used by consumers to appraise food quality is appearance, which is strongly convinced by color. Color is affecting food selection and perception of other sensory properties (Piagentini *et al.*, 2012).

Table 4. Sensory of cookies

Parameters	F1	F2	F3	F4
Color	3.60 ± 1.09a	3.80 ± 0.95a	3.65 ± 1.09a	3.70 ± 0.87a
Aroma	3.85 ± 1.14a	3.80 ± 0.89a	4.15 ± 0.81a	3.85 ± 0.99a
Taste	3.65 ± 1.23a	3.80 ± 1.20a	3.65 ± 1.23a	3.70 ± 1.03a
Texture	3.85 ± 0.88a	3.00 ± 1.08ab	2.70 ± 1.03b	3.75 ± 1.12a

Expressed values were mean±SD (n = 3); a same rows containing means with the same superscript letters are not significantly different (p < 0.05).

Color attribute of mocaf cookies in this paper strongly influenced by non-enzymatic browning reaction, that is interrelated to sensory quality. It helps to develop flavor, aroma, texture and color (44). Baking of cookies were undergoing Maillard reaction and caramelization. The Maillard reaction happens after reducing sugars and amino acids, proteins and/or other nitrogen-containing compounds from dough composition are heated at the same time. Caramelization describes a reactions that occur when carbohydrates (sucrose and reducing sugars) are heated (process of browning the sugar). Browning in baking products is not only affiliated with sensory aspects such as color and flavor creation, but also to nutritional values (45).

Incorporation of chicken meat and carrot puree on various level within mocaf cookies had a non-significant difference on the aroma of product (Table 4). The aroma of cookies was at the score range of 3.80-4.15, meaning all four cookies samples were given "like" label by children panelists. The butter composition used into the dough may contribute to the final aroma of cookies. This result was in line with a finding about dominant butter aroma on mocaf based cookies. Mocaf flour as the main ingredient in cookies has no specific cassava "musty" odor that affects the cookies smell (7). It makes the derivate products from mocaf cookies are more preferable than from cassava flour, beside the fact that mocaf flour is whiter in color quality.

The cookies taste was on the score range between 3.65 – 3.80 (Table 4). All formulations of mocaf cookies with diverse level of chicken meat and carrot puree were favored panelists with no significant difference. The cooked chicken meat and blanched carrot prior to dough mixing might have good effect to the taste on F1, F2, and F3 cookies, since both ingredients had caused no off-flavor at all. Compared to wheat cookies product with incorporation of chicken minced meat up to 20% (10), the taste score and overall acceptability were increased. Taste evaluation of this mocaf cookies was in harmony with carrot juice concentrate within wheat cookies gave unnotable score difference to the taste attribute (11).

Texture profile is inevitably affecting eating quality(46). F3 had the lowest score for texture evaluation (Table 4). Addition of carrot puree on level 12.5% and 37.5% caused the decreased texture preference by panelists. Regarding the composition of cookies formula, one of causes that induces texture changes is the loss or the gain of moisture content (47). Chicken meat and carrot puree bring additional moisture into the dough and affect the texture attribute after baking. This was in accordance with the decreased textural score after chicken minced meat incorporation on wheat cookies (10).

4- Conclusions

This present study denotes that incorporation of chicken meat and carrot puree to the mocaf cookies is an excellent coming up innovation to provide highly nutritive snack for boosting children's nutrition needs with favorable taste. Addition of both ingredients could effectively increase the content of protein and total dietary fiber on mocaf cookies. All cookies formulations were acceptable to children panelists. F4 formulation was considered the best cookies due to its

physical properties, chemical composition, and sensory attributes.

5- Acknowledgment

6- Reference

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