

## Sensory analysis of whole wheat bread loaves with the addition of jabuticaba peel flour

### *Análise sensorial de pães de forma integrais enriquecidos com farinha de casca de jabuticaba*

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**ABSTRACT:** Bread is widely used for the purpose of nutritional enrichment and is included in the diet of all social classes. The present work had the objective of sensorially analyzing whole wheat breads enriched with jabuticaba peel flour (JPF) in different proportions (control 0%, T1 2.5%, T2 4.9% and T3 7.2%). The sensory acceptance test was conducted with 50 untrained judges using the nine-point hedonic structured verbal scale (for the attributes of flavor, color, texture and overall acceptance) and a three-point scale for purchase intention. Microbiological analysis of coliforms at 45°C and Salmonella sp. were performed on the breads, which showed absence of these microorganisms. From the results obtained from the acceptance test, the acceptance indices were determined. The control bread and the bread with 2.5% JPF presented greater sensory acceptance for the overall impression and flavor attributes with significant differences in relation to T2 and T3, which presented no differences between them ( $p < 0.05$ ). There was no significant difference for the attributes of color, texture and aroma ( $p < 0.05$ ). It was verified that the addition of jabuticaba peel flour affected the consumer purchase decision, since, in general, the averages of acceptance and the indices of acceptability declined with the increase of the JPF; however, the loaves with addition of 4.9% and 7.2% JPF presented positive results, with results close to 7.0, and thus indicating potential insertion of whole wheat bread with the addition of jabuticaba peel flour into the market.

**Keywords:** Acceptance; Jabuticaba; Baking; Sensory.

**RESUMO:** Os pães são muito usados para fins de enriquecimento nutricional e estão incluídos na dieta de todas as classes sociais. O presente trabalho teve como objetivo analisar sensorialmente pães de forma integrais enriquecidos com farinha de casca de jabuticaba (FCJ) em diferentes proporções (controle 0%, T1 2,5%, T2 4,9% e T3 7,2%). O teste de aceitação sensorial foi conduzido com 50 julgadores não treinados, utilizando-se escala hedônica verbal estruturada de nove pontos (para os atributos sabor, cor, textura e aceitação global) e de três pontos para intenção de compra. Análises microbiológicas de coliformes a 45°C e Salmonella sp. foram realizadas nos pães, que apresentaram ausência destes microrganismos. A partir dos resultados obtidos do teste de aceitação, foram determinados os índices de aceitação. O pão controle e o pão com 2,5% de FCJ apresentaram maior aceitação sensorial para os atributos impressão global e sabor com diferenças significativas em relação à T2 e T3, que não apresentaram diferenças entre si ( $p < 0,05$ ). Não houve diferença significativa para os atributos cor, textura e aroma ( $p < 0,05$ ). Comprovou-se que a adição de farinha de casca de jabuticaba afetou a decisão de compra do consumidor, visto que, de maneira geral, as médias de aceitação e os índices de aceitabilidade dos pães decresceram com o aumento da adição da FCJ, entretanto os pães com adição de 4,9 e 7,2% de FCJ apresentaram resultados positivos, com notas próximas ou acima de 7,0, indicando potencial inserção de pães integrais com adição de farinha de casca de jabuticaba no mercado.

**Palavras-chave:** Aceitação; Jabuticaba; Panificação; Sensorial.

## INTRODUCTION

Many countries have adopted measures to reduce the consumption of processed foods in their populations' diets due to the assumption that habitual consumption of such products can increase the risk factors for the emergence of chronic diseases (FARDET; ROCK, 2019). In view of this trend, there has been, in recent years, an increase in the food industry's interest in researching new compounds that can be used to prepare foods that foster health benefits (DEL RÉ; JORGE, 2012; CONSTANTINO; LOPES, 2019).

It is known that jabuticaba peel flour is rich in anthocyanins and other phenolic compounds which, in addition to acting as antioxidants, also have anti-inflammatory, anti-mutagenic and anti-carcinogenic activity, and a high dietary fiber content (MILK- LEGATTI et al., 2012; SANTIAGO et al., 2018).

Breads are widely used for nutritional enrichment purposes, especially because they are one of the diet's main caloric sources, in addition to being included in the diets of all social classes (ENGINDENIZ; BOLATOVA, 2019). Therefore, investigating ingredients that can improve the nutritional characteristics of breads is pertinent to keep their production economically viable (RIBEIRO; FERREIRA; FERREIRA, 2019). Thus, bread enriched with jabuticaba peel flour can be an interesting alternative to diversify the sector as it adds value to the product and contributes positively to health maintenance (LENQUISTE et al., 2019).

Sensory analysis of food products provides fundamental indications for the production and marketing of products regarding consumer preferences and requirements, in addition to playing a prominent role in the development of new products (PALCZAK et al., 2019).

Therefore, this study aimed to sensorially analyze, through acceptance and purchase intention tests, different formulations of whole wheat bread enriched with jabuticaba peel flour.

## MATERIAL AND METHODS

### Production of jabuticaba peel flour

Ripe jabuticaba fruit (*Myrciaria jaboticaba*), of the Sabará variety, was obtained through communal donations from the city of Jacarezinho, PR, Brazil, in September of 2016. Soon after being received, the raw material underwent selection, cleaning and sanitization in sodium hypochlorite solution at 200 mg L<sup>-1</sup> for 15 minutes. Then, the jabuticabas were manually pulped and the peels were placed in a layer on aluminum baking sheets. The drying was performed in a forced air circulation oven at a temperature of 60°C for 12 hours (FERREIRA et al., 2012), and later crushed with the aid of a domestic blender. After obtaining the flour, it was packaged in a vacuum sealer in nylon bags with high-resistance polyethylene and stored in a freezer at -18 °C until use.

### Production of bread loaves with added jabuticaba peel flour

The loaves were produced using a standard formulation (conventional whole wheat bread) as a control treatment and three treatments with the addition of 2.5% (T1), 4.9% (T2)

and 7.2% (T3) jabuticaba peel flour (JPF) (Table 1).

**Table 1.** Whole wheat bread formulations produced with the addition of jabuticaba peel flour (JPF).

Ingredients*	T0	T1	T2	T3
Special wheat flour	20.5	20.0	19.5	19.1
Whole wheat flour	30.8	30.0	29.3	28.6
Jabuticaba peel flour	0.0	2.5	4.9	7.2
Water	35.4	34.5	33.7	32.9
Granulated sugar	6.2	6.0	5.9	5.7
Vegetable fat (80% lipids)	1.9	1.9	1.8	1.8
Salt	0.9	0.9	0.9	0.9
Whole powdered milk	1.5	1.5	1.5	1.4
Instant dry yeast	1.0	1.0	1.0	1.0
Alpha-amylase enzyme	0.5	0.5	0.5	0.5
Calcium Propionate	0.1	0.1	0.1	0.1
Vital wheat gluten	1.0	1.0	1.0	1.0

\*Percentages of ingredients in bread formulations on a wet basis.

T0= Whole wheat bread without the addition of jabuticaba peel flour;

T1= Whole wheat bread with 2.5% jabuticaba peel flour;

T2= Whole wheat bread with 4.9% jabuticaba peel flour;

T3= Whole wheat bread with 7.2% jabuticaba peel flour.

Source: SENAI, 2015.

To prepare the loaves, all the ingredients of the formulation were weighed on an analytical balance and subsequently put into a Britânia Multi Pane automatic kneading machine, adding first the dry ingredients and then the wet ones. In the kneading machine, there were the operations of mixing the ingredients, kneading, letting the dough rest, kneading again, final fermentation and finally baking, as instructed in the Bread Preparation Manual for the Britânia equipment. After baking, the loaves were unpanned and cooled at room temperature to then be manually sliced at an average thickness of 25 mm (**Figure 1**). The slices were packed in a vacuum sealer in nylon bags with high-resistance polyethylene and stored in a freezer at -18°C until use.

## Determination of microbiological quality

The breads were subjected to microbiological analyses required by the National Health Regulatory Agency - ANVISA, according to the guidelines of Resolution - RDC No. 12, of January 2, 2001 (BRASIL, 2001) for this food product category, that is, *Salmonella* sp. and Coliforms at 45°C, according to the methodology used by Silva et al. (2010).

**Figure 1.** Whole wheat breads with the addition of 0 (T0), 2.5% (T1), 4.9% (T2) and 7.2% (T3) jabuticaba peel flour in partial substitution of wheat flour.



### Sensory analysis

The sensory analysis of the loaves was performed with authorization from the Ethics Committee of the Federal University of Triângulo Mineiro - UFTM, under CAAE 43948015.7.0000.5154 at the Sensory Analysis Laboratory of the Federal Institute of Paraná - IFPR - Jacarezinho campus. The judges, before performing the sensory analyses, read and signed the Informed Consent Form, after clarification.

The formulations were sensorially evaluated by 50 judges using the acceptance test (MEILGAARD; CIVILLE; CARR, 1991). The samples were served in a balanced order and in a monadic manner.

In the acceptance test, the attributes color, aroma, flavor, texture and overall impression for each formulation were evaluated using a form containing a nine-point hedonic structured verbal scale, where 1 = disliked very much and 9 = liked very much.

For the purchase intention, the same form was adopted, containing a three-point structured verbal scale that ranged from 1 = would definitely not buy and 3 = would definitely buy (MEILGAARD; CIVILLE; CARR, 1991; IAL, 2008).

### Result analysis methodology

The sensory analysis and acceptance test results were submitted to a complete block design with one control and three treatments (addition of 2.5, 4.9 and 7.2% JPF), considering 50 judges. The treatment effects were submitted to analysis of variance (ANOVA) and the means were classified by the Tukey test at 5% probability in order to identify differences. The results were submitted to statistical analysis using the STATISTICA

software version 13.0.

For purchase intention, the results were tabulated as percentages, ranging from “I would definitely not buy” to “I would definitely buy” the product.

To calculate the product’s Index of Acceptability, equation 1 was adopted:

$$IA (\%) = A \times 100 / B \quad (1)$$

In which IA is the index of acceptability, A is the average score obtained for the product and B is the maximum score given to the product.

The IA with good impact was considered  $\geq 70\%$  (DUTCOSKY, 2011).

## RESULTS AND DISCUSSION

### Microbiological results

In addition to nutritional quality, the microbiological quality of food is essential for consumer health and safety. The developed breads were evaluated according to the microbiological standards provided for in the RDC of January 12, 2001 (BRASIL, 2001), before sensory tests (**Table 2**).

**Table 2.** Microbiological evaluation of whole wheat breads with the addition of different proportions of jabuticaba peel flour.

Microbiological analyses	Treatments			
	T0	T1	T2	T3
Coliformes at 45°C g <sup>-1</sup> (MPN.g <sup>-1</sup> )*	< 3.0	< 3.0	< 3.0	< 3.0
<i>Salmonella</i> sp 25 g <sup>-1</sup> (Absence)	Abs**	Abs	Abs	Abs

\*MPN.g<sup>-1</sup> : Most Probable Number per gram of sample. \*\*Abs: Absence.

T0= Whole wheat bread without the addition of jabuticaba peel flour;

T1= Whole wheat bread with 2.5% jabuticaba peel flour;

T2= Whole wheat bread with 4.9% jabuticaba peel flour;

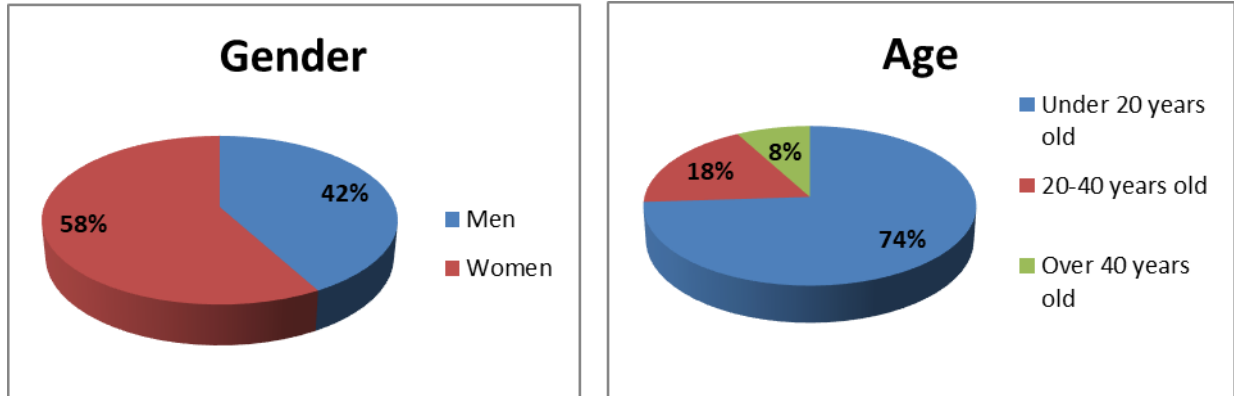
T3= Whole wheat bread with 7.2% jabuticaba peel flour.

From the analysis of microbiological results (**Table 2**), it can be stated that the four formulations were suitable for consumption in regards to microbiological criteria, therefore allowing the use of samples for sensory tests.

### Sensory results

The results of the sensory evaluation forms led to indicators (**Figure 2**) that most of the judges who evaluated the breads were women (58%), under the age of 20 (74%).

**Figure 2.** Profiles of the judges participating in sensory acceptance and purchase intention tests applied to whole wheat breads with the addition of different proportions of jabuticaba peel flour.



The acceptance test results for the bread formulations are presented in **Table 3**.

**Table 3.** Sensory analysis results of acceptance of whole wheat breads with addition of different proportions of jabuticaba peel flour.

Attributes	Treatments			
	T0	T1	T2	T3
Color	7.58 <sup>a</sup> ±1.34	7.18 <sup>a</sup> ±1.41	6.92 <sup>a</sup> ±1.60	7.14 <sup>a</sup> ±1.39
Texture	7.54 <sup>a</sup> ±1.43	7.18 <sup>a</sup> ±1.38	7.38 <sup>a</sup> ±1.47	6.96 <sup>a</sup> ±1.81
Flavor	7.58 <sup>a</sup> ±1.51	7.12 <sup>a,b</sup> ±1.41	7.00 <sup>a,b</sup> ±1.71	6.64 <sup>b</sup> ±1.63
Aroma	7.18 <sup>a</sup> ±1.69	7.02 <sup>a</sup> ±1.49	6.90 <sup>a</sup> ±1.68	6.66 <sup>a</sup> ±2.02
Overall impression	7.76 <sup>a</sup> ±1.05	7.37 <sup>a</sup> ±1.15	6.43 <sup>b</sup> ±1.89	6.47 <sup>b</sup> ±1.77

\*Means followed by the same letter on the same line do not differ from each other by the Tukey Test ( $p < 0.05$ ).

T0= Whole wheat bread without the addition of jabuticaba peel flour;

T1= Whole wheat bread with 2.5% jabuticaba peel flour;

T2= Whole wheat bread with 4.9% jabuticaba peel flour;

T3= Whole wheat bread with 7.2% jabuticaba peel flour.

The breads T0, T1, T2 and T3 did not differ statistically from each other in terms of color, texture and aroma.

According to Torbica et al. (2019), color is one of the attributes that has the greatest impact on a judge's assessment because from the color, consumers assess the quality of the product as a whole since color is generally associated with flavor and texture. According to the judges, in regards to the attribute of color, the addition of JPF did not significantly affect the bread color.

The T0 (control) and T1 breads were the most accepted in regards to overall impression, with significant differences in relation to T2 and T3, which did not differ from each other. The T0 and T1 breads received scores that ranged between "I quite liked it" and "I liked it a lot", and the T2 and T3 breads received scores that ranged between "I somewhat liked it" and "I quite liked it" for overall impression (**Table 3**). A trend of lower acceptance of the breads for global impression was noticed as the JPF percentages in the formulations

increased.

Regarding flavor, T1 and T2 did not differ from T0 and T3, but T0 and T3 differed from each other ( $p < 0.05$ ). The same trend was observed regarding flavor for which formulations with higher contents of JPF had lower average acceptance values.

Lower acceptances of formulations T2 and T3 were expected. This was probably due to less familiarity with a new ingredient (JPF) in the breads.

Appelt et al. (2015) evaluated three cereal bar formulations based on okara flour with different proportions of jabuticaba peel flour and did not identify significant differences in the aroma, color and texture of the formulations. Similar to the present study for T0 and T1, the average scores given by the judges in the acceptance test were higher than 7 for all attributes evaluated (color, flavor, texture, aroma and overall impression), thus indicating good acceptance by the judges.

Ferreira et al. (2012) developed cookies with jabuticaba peel flour and noticed that all attributes evaluated in the acceptance test (color, appearance, aroma, flavor, sweetness, acidity and texture) obtained decreasing scores as the content of jabuticaba peel flour increased, corroborating the present study regarding flavor and overall impression. The authors concluded that, in general, cookies without JPF and cookies with an addition of 5% JPF were the ones given the highest scores and indices of acceptability by the judges.

Eshak (2016) sensorially evaluated breads supplemented with 0%, 5% and 10% banana peel and the results indicated small differences between the overall impression scores (8.6, 8.3 and 8.2, respectively), which decreased as the concentration of banana peel increased, as observed in this work for the attributes of flavor and overall impression.

It is commonly observed that the sensory characteristics of breads are influenced by the addition of fibers from different agro-industry by-products (MARTINS; PINHO; FERREIRA, 2017). In this work, a decrease in the sensory acceptance of breads with the addition of different fruit-derived products was observed in other studies. Such fruit-derived products include pomegranate peel, grapefruit peel, grape pomace flour, pineapple pomace fiber, powdered mango peel, mango peel, mango seeds and lemon fiber (CHANG; LI; SHIAU, 2015; CHAREONTHAIKIJ; UAN-ON; PRINYAWIWATKUL, 2016; PATHAK et al., 2016; SULIEMAN et al., 2016; RESHMIA; SUDHAB; SHASHIREKH, 2017; ŠPORIN et al. 2018; IBRAHIM et al., 2018). In many cases, the decrease in acceptance is justified by the change in the physical structure, since the addition of fiber hinders the creation of the aerated structure, the main characteristic of bread (QUILES et al., 2018; GÓMES; MARTINEZ, 2018).

In this study, all the attributes for the breads had acceptance rates above 70% (**Table 4**), which evidenced a satisfactory sensory acceptance. Dutcosky (2011) mentions that for a product to be accepted in terms of its sensory characteristics, it is necessary that its index of acceptability be at least 70%.

However, it was noticed that as the proportion of JPF increased, the absolute indices of acceptability decreased, as already reported for the overall impression and flavor.

**Table 4.** Index of acceptability (IA) of the whole wheat breads with the addition of different proportions of jabuticaba peel flour.

Attributes	Treatments			
	T0	T1	T2	T3
Color	84.22	79.78	76.89	79.33
Texture	83.78	79.78	82.00	77.33
Flavor	84.22	79.11	77.78	73.78
Aroma	79.78	78.00	76.67	74.00
Overall impression	86.78	82.76	72.80	72.99
IA total (%)	83.54	79.42	77.54	75.72

T0= Whole wheat bread without the addition of jabuticaba peel flour;

T1= Whole wheat bread with 2.5% jabuticaba peel flour;

T2= Whole wheat bread with 4.9% jabuticaba peel flour;

T3= Whole wheat bread with 7.2% jabuticaba peel flour.

Khalil et al. (2017) sensorially evaluated unleavened bread supplemented with green banana flour (GBF) and obtained results similar to those observed in this work. The control sample had the highest total index of acceptability, 95.75%, with a decrease in the indices as the proportion of GBF increased: 93.50% (10% GBF); 92.00% (20% GBF); 82.28% (30% GBF); 74.37% (40% GBF); 69.25% (50% GBF).

Similar to this study, Gül and Şen (2017) studied the effects of replacing wheat flour in bread with pomegranate seed flour (PSF) in the proportions of 0; 5; 7.5 and 10%, and Chareonthaikij, Uan-on and Prinyawiwatkul (2016) studied the effects of adding pineapple pomace fiber (PPF) to breads in the proportions of 0; 5 and 10%. Both studies verified a better sensory evaluation of breads with 5% PSF and PPF, respectively.

**Figure 3** presents the results of the judges' purchase intentions in relation to the whole wheat breads with different proportions of JPF.

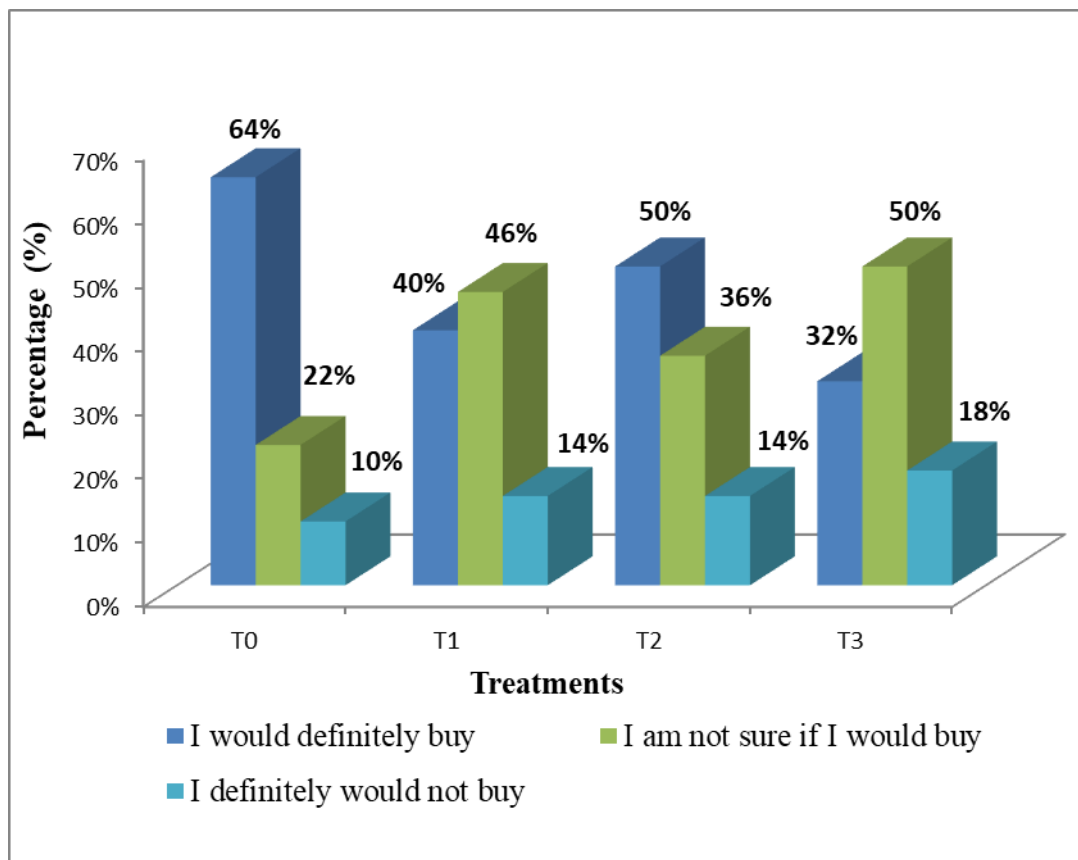
The means obtained were, in general, between scores 2 (I am not sure if I would buy) and 3 (I would definitely buy) for all treatments.

The purchase intention tests were compatible with the results of the acceptance test as T0 presented higher scores for the evaluated attributes, followed by T1 and T2 and T3. Therefore, it was proven that the addition of jabuticaba peel flour affected the consumer's purchase decision, since, in general, the acceptance averages decreased with the increase in the addition of JPF.

It was found that the purchase intention had no direct relationship with the index of acceptability. This was especially true for T2, which presented a purchase intention of 50% for "would definitely buy", but had the lowest overall impression value (6.43). The non-concordance between the index of acceptability and the purchase intention may occur because it is a new product and, therefore, there are few similar products on the market. Another justification may be the fact that the evaluations were carried out by untrained judges representing the consumer public.



**Figure 3.** Purchase intention histogram for whole wheat breads with the addition of different proportions of jabuticaba peel flour.



T0= Whole wheat bread without the addition of jabuticaba peel flour;

T1= Whole wheat bread with 2.5% jabuticaba peel flour;

T2= Whole wheat bread with 4.9% jabuticaba peel flour;

T3= Whole wheat bread with 7.2% jabuticaba peel flour.

## CONCLUSIONS

According to the results, it was possible to conclude that the whole wheat breads with the addition of jabuticaba peel flour met the standards established in legislation, thus indicating the quality of the baked product and its adequacy for the sensory analysis.

The control bread and the bread with 2.5% JPF showed greater sensory acceptance in all attributes; however, the breads with the addition of 4.9 and 7.2% JPF showed positive results, with scores close to or above 7.0, indicating potential insertion of whole wheat breads with the addition of jabuticaba peel flour into the consumer market.

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Received on: 2020/06/18  
Approved on: 2021/04/19