

Comparing Masticatory Performance as Measured by Gummy Jelly and Color-Changeable Chewing Gum in Dentate Subjects

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Abstract

Masticatory ability is an important aspect of stomatognathic function that affects the oral health-related quality of life in everyone. A practical way to objectively measure masticatory ability is to use color-changeable chewing gum and gummy jelly. The purpose of this study was to analyze the relationship between the masticatory ability measurements obtained with color-changeable chewing gum and gummy jelly. The subjects were fully dentate individuals (n = 10). Subjects' masticatory function was measured by asking them to masticate color-changeable chewing gum at 30, 45, and 60 strokes and gummy jelly at 10, 20, and 30 strokes. The measurement used a validated visual chart. Spearman correlation was used to analyze the data. A significant correlation ($p < 0.05$) was found between the measurement of 30 strokes of chewing gum and 20 strokes of gummy jelly ($r = 0.643$, $p = 0.045$), between 45 strokes of gum and 10 strokes of jelly ($r = 0.701$, $p = 0.007$), between 60 strokes of gum and 10 strokes of jelly ($r = 0.756$, $p = 0.011$), and between 60 strokes of gum and 30 strokes of jelly ($r = 0.684$, $p = 0.029$). It was suggested that two methods for measuring masticatory performance could be comparable by considering the number of chewing cycles: 60 strokes for color-changeable chewing gum and 30 strokes for gummy jelly.

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Introduction

Masticatory ability is an important aspect of stomatognathic function that affects oral health-related quality of life. Low masticatory performance has been found to relate to underweight conditions in children.¹ In older populations, low masticatory ability can relate to lower daily activities and cognitive function, higher risk of depression, and greater food insufficiency.²

Masticatory performance comprises several factors, such as comminution and mixing, and no single method can evaluate all of these aspects. There are several methods available for

measuring masticatory performance, such as paraffin wax, natural test food, artificial test food, two-color chewing gum, and color-changeable chewing gum. Masticatory performance tests that evaluate comminuting ability usually use natural and artificial test food (e.g., peanuts, gummy jelly), while evaluations of mixing ability usually use chewing gum.^{3,4} Evaluation of the material can be done with specific instruments for research purposes or visually for more general purposes, such as evaluation of masticatory performance in daily practice.

Gummy jelly containing a β -carotene concentration can quantitatively evaluate masticatory performance by calculating the surface area of comminuted parts. These methods need special equipment for processing data. However, there are visual evaluation methods that simplify the process and have already been validated.^{5,6} A color-changeable chewing gum can be used to evaluate mixing ability. The chewing gum changes color before

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mixing and before any chemical reactions. The color of the Chewing gum is then measured with a colorimeter or with a validated color scale.⁷ The purpose of this study was to analyze the relationship between the masticatory measurements obtained with color-changeable chewing gum and with gummy jelly.

Materials and methods

The design of the study is cross-sectional. This study was done in the Dental Teaching Hospital, Faculty of Dentistry, Universitas Indonesia, and was approved by the ethical committee of the Faculty of Dentistry, Universitas Indonesia (No. 27/Ethical Approval/FKGUI/VII/2016). The subjects were taken by consecutive sampling of 10 fully dentate subjects. The inclusion criteria were willingness and ability to give consent for study participation, non-Muslim, and no history of temporomandibular disorders.

Subjects' masticatory performance was evaluated using color-changeable chewing gum (Masticatory Performance Evaluating Gum Xylitol, Lotte Co., Ltd. Saitama, Japan) and Test Gummy Jelly (UHA Mikakuto, Osaka, Japan). Subjects were asked to chew the color-changeable chewing gum and gummy jelly for 30, 45, and 60 strokes and 10, 20, and 30 strokes.

The chewed gum was flattened to 1.5mm thickness by compressing it using two glass plates and measured using the color chart. For the gummy jelly, the chewed pieces were spat out by subjects into a paper glass already covered by gauze and measured using the visual chart.

The measurements were repeated three times for each level of stroke on both chewing gum and gummy jelly. Statistical analysis was performed using SPSS software. Spearman's rank correlation coefficients were used to analyze the correlation between chewing gum and gummy jelly measurements.

Results

In this study, 10 subjects were recruited, ranging in age from 24 to 38 years old (mean 28.80). The median score for masticatory performance of both color-changeable chewing gum and gummy jelly at different strokes is shown in Table 1.

A statistically significant correlation was found between the measurement of 30 strokes of chewing gum and 20 strokes of gummy jelly ($r = 0.643$, $p = 0.045$), 45 strokes of chewing gum and 10 strokes of gummy jelly ($r = 0.701$, $p = 0.007$), 60 strokes of chewing gum and 10 strokes of gummy jelly ($r = 0.756$, $p = 0.011$), and 60 strokes of chewing gum and 30 strokes of gummy jelly ($r = 0.684$, $p = 0.029$).

Material	Number of Strokes	Median (Min-Max)
Chewing Gum	30	3 (2-5)
	45	5 (3-8)
	60	7.5 (5-9)
Gummy Jelly	10	3.5 (1-5)
	20	6 (3-7)
	30	8 (6-9)

Table 1. Visual Score of Color-Changeable Chewing Gum and Gummy Jelly.

Discussion

Various methods have been used to objectively measure masticatory performance. Komigamine et al. stated that one of the methods is color-changeable chewing gum. This method is easy and has the advantages of simulating a natural and stable act of chewing while still allowing complete recovery of the test item. Given these advantages, color-changeable chewing gum has been applied in various fields.^{8,9} Gummy jelly has the advantages of being able to be chewed and swallowed in the same manner as regular food, and sufficiently reflects the required functions from intake to immediately before swallowing.⁵

This study aimed to compare masticatory performance as measured by gummy jelly and color-changeable chewing gum in dentate subjects. The score of masticatory performance of subjects with full dentition as measured by using both the gummy jelly and chewing gum at different strokes can be used as a baseline for comparison in another study, such as with denture wearers, as prosthodontic treatments are performed to recover masticatory function as in natural dentition.

Masticatory performance measurement using the gummy jelly and color-changeable chewing gum was convenient and easy to perform in daily practice. Gummy jelly can represent the comminuting ability, which is the ability to crush food bolus from large to small particles. Color-changeable chewing gum can

measure mixing ability. Hama et al. suggested that 60 strokes of color-changeable chewing gum are optimal for dentate subjects. As for gummy jelly, there was no standard in strokes of measurement. Measurement of comminuting ability using another method suggests 10 and 20 chewing strokes, as has been done by van der Bilt et al. Both measurements using gummy jelly and color-changeable chewing gum can be performed using a visual evaluation that has already been validated.^{6,3}

The median scores for chewing gum in this study were 3, 5, and 7 for 30, 45, and 60 strokes. These scores can be used as a baseline for masticatory performance measurement using color-changeable chewing gum in other group of subjects, such as denture wearers, with the same number of strokes. On the other hand, the author agrees with Hama et al.'s suggestion of 60 strokes for color-changeable chewing gum measurement. Lower numbers of strokes (45 and 60 strokes) give lower scores, which conflicts with the assumption that fully dentate subjects have good masticatory performance. In gummy jelly measurement, the median scores were 3, 5, 6, and 8 for 10, 20, and 30 strokes. These findings show that the range of scoring in color-changeable chewing gum is similar in gummy jelly measurements with a lower number of strokes. In the author's opinion, 30 strokes of gummy jelly measurement is optimal in fully dentate subjects, as a larger number of strokes will result in smaller pieces of gummy jelly, which are difficult to retrieve from subjects and are at a greater risk of being accidentally swallowed.

There was a significant correlation between measurements using gummy jelly and color-changeable chewing gum for a different number of strokes, as shown in Table 2. Subjects that have a good mixing ability also have a good comminuting ability. Although, according to van der Bilt, a subject may have good masticatory performance in comminuting but may be relatively bad in mixing, from these results, it is suggested that two methods for measuring masticatory performance could be comparable by considering the number of chewing cycles.¹⁰ There was some limitations on this study. The sample size was minimal; thus, further studies are necessary to increase sample size. Another difficulty was that both the gummy jelly and color-changeable chewing gum were not available in Indonesia and must be ordered and imported

directly from Japan. As for gummy jelly, it contains substances that are labeled non-halal in Indonesia. Therefore, only non-Muslims can participate as subjects. This condition will limit the use of gummy jelly as a test for masticatory performance in Indonesia in the future, despite the simple and easy-to-use properties of the gummy jelly.

Conclusion

From this study, it was suggested that two methods for measuring masticatory performance could be comparable by considering the number of chewing cycles. Masticatory performance measurement can use 60 strokes for color-changeable chewing gum and 30 strokes for gummy jelly measurement.

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Declaration of Interest

The authors report no conflict of interest.

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