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# Evaluation on safety and sensory analysis of xylitol substituted *dadih*

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**Abstract**

*Dadih* is a favourable dessert in South East Asia due to its appealing sweet taste and jellies appearance. The sweet taste is from sugar (sucrose) content, and in order to reduce the sucrose, it was substituted with xylitol. Xylitol can provides intense sweetness with less calories and lower water activity, which potentially contribute to higher microbial stability thus giving longer shelf life. The objective of this study was to evaluate the effect of xylitol substituted on *dadih* safety and sensory qualities. *Dadih* was prepared by replacing sucrose with xylitol composition in the range of 0 – 100% and at two levels of cooking times (15 and 20 minutes). Safety analysis were performed using total plate count (TPC) and water activity ($a_w$) analysis. For sensory analysis, seven attributes were evaluated (appearance, colour, hardness, elasticity, taste, sweetness, and overall acceptability) based on the 9-hedonic scale. From the findings, *dadih* samples with total sucrose (0%) were observed to be contaminated faster compared to total xylitol (100%). *Dadih* with xylitol is more stable with prolonged shelf life. From sensory analysis, *dadih* sample prepared with shorter cooking time (15 minutes) was selected as more favourable with overall acceptability score between 72 - 85%. More than 70% of the score for *dadih* with xylitol substitute was above 'slightly like', which indicates a promising future to produce xylitol substitute *dadih*. The outcome of this study has shown that xylitol is potentially to be utilize as sugar substitute for *dadih* production.



## Introduction

Today, the food market in South East Asian is flooded with variety of dairy products, and *dadih* is one of the favourable product especially to Malaysian. It is a dessert which the texture has custard-like, sweet taste and jellies appearance (Mohd Thani *et al*., 2014). Due to the increase in demand from consumers for healthy food products that contain less sugar and sugar free content, this study is aiming to substitute the sucrose (sugar) in the formulation of making *dadih* with sugar substitute.

Xylitol has many advantages as a sugar substitute in food products. Xylitol is sugar polyalcohol that has been used in food processing, odontological, and pharmaceutical industries. It possesses a sweetening power comparable to sucrose (Parajo *et al*., 1998). Xylitol can potentially reduce the energy of *dadih* since it contains less 40% energy compared to sucrose (Winkelhausen *et al*., 2007). At equal concentration, xylitol has lower water activity than sucrose, and products such as jam (Hyvönen and Törmä,1983) and cookies (Winkelhausen *et al*., 2007) that formulated with xylitol was found stable for longer periods.

To produce a new product with less sugar such as xylitol substituted *dadih*, safety and acceptability of customer to a new product is important. Safety analysis needs to be conducted in order to predict the stability and product quality of xylitol substituted *dadih* while sensory evaluation is needed to recognise the opinion of the potential customer. Therefore, the objective of this study was to evaluate the effect of xylitol substituted on *dadih* safety and sensory qualities.

## Materials and Methods

### *Dadih preparation*

Formulation of *dadih* consisted of distilled water (46.92 v/v), low fat milk (46.92 v/v), commercial agar powder (0.52 w/v), salt (0.01 w/v), and sugar (5.63% w/v). Food grade xylitol was purchased from a local company, while other ingredients were purchased from local supermarket. *Dadih* was prepared with sugar substituted with xylitol in five level different of sugar compositions 0% (total sucrose), 25% (75%

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of sucrose), 50% (50% sucrose), 75% (25% sucrose) and 100% (total xylitol). Substitution was done on weight basis of sucrose (sugar) used. The cooking time was set up at two points, 15 and 20 minutes. *Dadih* samples were prepared as suggested by Mohd Thani *et al*. (2014) and Ishak *et al*. (2006 ) with some modifications particularly on sucrose compositions. All powder ingredients were mixed and manually stirred at room temperature (25 ± 2°C) for 5 minutes. Later, the samples were heated in the water bath with fixed cooking time at constant temperature (85°C) and stirring speed (120 rpm). Afterwards, the solution was cooled to 40°C in a control room to form stable gelation. Then, the samples were left undisturbed for 24 hours in a chiller at 4°C. The samples were ready for analysis after 24 hours of storage.

*Dadih safety analysis*

In this study, two types of analysis were performed: Total Plate Count (TPC) and water activity analysis. Total Plate Count (TPC) was used to enumerate the amount of viable bacteria in a product sample as key indicator of the overall product expected quality and safety once it reaches consumers. *Dadih* is categorised as dairy products, which dairy products and milk are generally accepted as safe if the total aerobic count is not exceeding $1X10^5$ per gram (Food Regulations, 1985). Both analyses were conducted up to 25 days and all the experiments were conducted in triplicate (n=3).

*Total plate count*

The plate count agar was prepared by suspending 23.5 grams of media powder in 1000 ml distilled water. Then, the solution was boiled to dissolve the medium completely. The medium was then sterilized by autoclaving at 15 lbs pressure (121°C) for 15 minutes. Finally, after mixing them well, the media was poured into sterile petri plates (Wehr and Frank, 2004). Next, for microbial analysis, 10 g of each *dadih* sample was aseptically weighted. The sample was placed onto the sterile stomacher bag which contained 90 ml of peptone water. It was then homogenized through shaking method using a stomacher blender for 2 minutes. 1 ml of the homogenate was serially diluted into 9 ml of peptone water. The sample was assigned as dilution $10^{-1}$. The dilution process was repeated until the sample reached dilution $10^{-5}$. 0.1 ml of each dilution was spread on the plate count agar. Samples were done in triplicate and they were incubated for 48 hours at 37°C. The colony growth on the plate agar was counted using a colony counter (Insausti *et al*., 2001). In this experiment, three samples were tested separately for the analysis and mean values of total plate counts from triplicate plates are given.

*Water activity*

Water activity meter (GBX-France Laboratory Water Activity model) was switched on 20 minutes prior to the analysis. It was then calibrated using distilled water. Three water activity chambers (triplicate) were filled with samples up to the indicated line. Samples were then inserted into water activity meter and values of water activity were read and recorded from the meter display. In this experiment, two samples were tested separately for the analysis.

*Sensory evaluation*

Sensory evaluation was involved with 40 untrained panellists. Every panellists were given four different samples (a) 85˚C-15 mins-0%, (b) 85˚C-15 mins-100%, (c) 85˚C-20 mins-0% and (d) 85˚C-20 mins-100%, with a mineral water to rinse their mouth. This sensory evaluation test was done according to 9-point hedonic scale (Peryam and Pilgrim, 1957) where the points were from "Dislike Very Much" until "Like Very Much". The score of preference is shown at Table 1. The panellists were asked to taste the sample and give the score accordingly. Seven sensory attributes were selected to be evaluate, which were appearance, colour, hardness, elasticity, taste, sweetness, and lastly overall acceptability.

**Table 1** Scores and preferences for 9-point Hedonic scale

| Score | Preferences |
|---|---|
| 1 | Dislike Very Much |
| 2 | Dislike Much |
| 3 | Dislike Moderately |
| 4 | Slightly Dislike |
| 5 | Neither Like Nor Dislike |
| 6 | Slightly Like |
| 7 | Like Moderately |
| 8 | Like Much |
| 9 | Like Very Much |

*Data analysis*

All the data obtained was calculated and analyze using Minitab 17 software. Two-way analysis of variance (ANOVA) with 95% confidence level was performed to study the sensory analysis in every test. The P-value indicate the significant differences of the responses measured.

## Results and Discussions

*Total plate count (TPC)*

Samples underwent storage at temperature 4˚C (located in chiller) with various storage durations (0, 5, 10, 15, 16, 18, 21, 23, 24 and 25 days). At Day 23, there was microbial growth in some of the samples while other samples remained unspoiled, this indicates that all samples were safe to be consumed up until Day 23. The shelf life of *dadih* without any preservative can be predicted to last until Day 21th to 22nd. Muir and Banks (2000) also stated that dairy product such as yogurt has a shelf life between 14 to 21 days.

Table 2 exhibits that microbial growth was first detected on nine out of thirty samples on Day 23. *Dadih* samples with total sucrose (0% xylitol) were among the first samples with microbial growth. However, among three spoiled samples, there were no apparent physical changes in terms of colour, odour and texture. Throughout 23 storage days, sample with 85˚C, 15 minutes cooking time and 0% xylitol contained the highest number of CFU/g (34.1±2.687), followed by sample from the same cooking condition but with 25% xylitol substitution (32.5±0.707). The least CFU/g was detected on Day 23 at 4.15±0.212, which was from sample of 85˚C, 20 minutes cooking time and 0% xylitol substitution. All samples with total sucrose contained microbial growth regardless of cooking time. Samples with 15 min of cooking time had higher CFU/g compared to samples that were cooked at 20 min. When the samples were cooked longer, more microbes were killed due to heat which possible to prolong the shelf life of *dadih*.

Nonetheless, all samples were detected with microbial growth on Day 24. Most of the samples reported >300 CFU/g, except for two samples that have TFTC (Too Few To Count) CFU/g, having parameters of 85˚C, 20 minutes cooking time and 75% xylitol substitution as well as 85˚C, 20 minutes cooking time and 100% xylitol substitution. These samples started to show obscure physical changes, such as yellowish colour and unpleasant smell. Finally on Day 25, all samples had >300 CFU/g. All samples demonstrated clear physical changes, where the colour had turn brownish, strong unpleasant smell with very soft texture which indicates it has changed from solid to semi solid. Due to the significant physical changes compared to initial form the samples are considered not safe to be consumed.

From total plate count analysis, *dadih* samples with high xylitol substitution have potentially longer shelf life as it has lower CFU/g. Thus, addition of xylitol in food products may possibly prolong the shelf life of the products (Winkelhausen *et al*., 2007). The potential reason might be xylitol is related with relatively exceptional capability of microorganisms to metabolize xylitol compared to microbial utilization of hexoses (Finley and Leveille, 1996). Winkelhausen *et al*. (2007) and Mushtaq *et al*. (2010) have also found that as xylitol substitution to baked product such as cookies have lower microbial growth compared to food product with sucrose.

Table 2 Number of organism per gram (log10 CFU/g) for all samples from day 23 until day 25

| Sample | | | Numbers of organism per gram | | |
|---|---|---|---|---|---|
| Temperature (˚C) | Time (minutes) | Xylitol (%) | Day 23 | Day 24 | Day 25 |
| 85 | 15 | 0 | 34.1 ± 2.687 | >300 | >300 |
| | | 25 | 32.5 ± 0.707 | >300 | >300 |
| | | 50 | 0 | >300 | >300 |
| | | 75 | 0 | >300 | >300 |
| | | 100 | 0 | >300 | >300 |
| 85 | 20 | 0 | 4.15 ± 0.212 | >300 | >300 |
| | | 25 | 0 | >300 | >300 |
| | | 50 | 0 | >300 | >300 |
| | | 75 | 0 | TFTC | >300 |
| | | 100 | 0 | TFTC | >300 |

*Data are Mean±Standard Deviation of triplicate measurements.

**TFTC: Too few to count which there is less than 30 colonies

*Water activity*

Water activity ($a_w$) of food is an important physical property in food formulations and processes, which the biochemical and microbiological are controlled directly by water activity of the system (Sahin and Sumnu, 2006). If water activity decreases, microorganism with the ability to grow will decrease. As mentioned earlier, the microbial growth was detected on Day 23. The following discussion focus on storage days when *dadih* started to spoil. From Table 3, water activity ($a_w$) for all samples increased throughout storage days starting from Day 23 until Day 25. On Day 23, samples prepared at 15 minutes of cooking time possessed higher value of $a_w$ when compared with samples prepared at lower cooking time (15 minutes). At both cooking time (15 and 20 minutes) of samples prepared with total sucrose (0%) had lower values of $a_w$ than samples with total xylitol (100%).

On Day 24, only two samples, which were samples 20 minutes cooking time (75% and 100%

xylitol substitution) showed lower $a_w$, 0.989 and 0.98 respectively, while other samples reached maximum $a_w$ (1.00) which indicates the samples was spoiled and no longer safe to be consumed. The finding is in agreement with total plate count analysis where Day 24 recorded >300 organisms per gram for majority of the samples. During Day 25, all samples showed maximum $a_w$ (1.00) indicating the food was spoilt. These findings supported total plate count analysis where all samples were no longer safe to be consumed at Day 25.

As the amount of xylitol increased in the sample, the water activity was decreased. There was also the same discovery in shelf life study where water activity ($a_w$) of cookies made with xylitol was lower compared with the ones made with sucrose (Mushtaq *et al*., 2010). This might due to the molecular weight of both xylitol and sucrose. According to Bond and Dunning (2006), xylitol exerts a higher osmotic pressure thus provides a lower water activity than equivalent solution of sucrose. This shows that xylitol effectively exerts a greater preservative effect in solution than sucrose. Another explanation, might be because of the natural characteristic of xylitol where it has lower $a_w$ than sucrose, thus contributing to the microbial stability and shelf life of the product (Parajo *et al*., 1998).

Table 3. Water activity ($a_w$) from day 23 until day 25

| Sample | | | Water Activity ($a_w$) | | |
|---|---|---|---|---|---|
| Temperature (˚C) | Time (minutes) | Xylitol (%) | Day 23 | Day 24 | Day 25 |
| 85 | 15 | 0 | 0.953 | 1 | 1 |
| | | 25 | 0.948 | 1 | 1 |
| | | 50 | 0.947 | 1 | 1 |
| | | 75 | 0.945 | 1 | 1 |
| | | 100 | 0.945 | 1 | 1 |
| 85 | 20 | 0 | 0.952 | 1 | 1 |
| | | 25 | 0.946 | 1 | 1 |
| | | 50 | 0.945 | 1 | 1 |
| | | 75 | 0.945 | 0.989 | 1 |
| | | 100 | 0.944 | 0.98 | 1 |

*Values are mean of triplicate measurements

*Sensory evaluation*

The sensory evaluations were done by 40 untrained panellists in a control condition at sensory laboratory. The sensory method for this study was using 9-point hedonic scale where the score is from "dislike very much" until "like very much". Only four samples with different cooking time (15 and 20 minutes), and at total sucrose (0%) and total xylitol (100%) substitution were selected for the sensory analysis. Table 4 represents the sensory analysis score of the samples.

Four sensory attributes of appearance, colour, hardness, and elasticity were focused on physical characteristics of *dadih*. For appearance and colour attributes, there were no significance ($p>0.005$) difference between all samples (Table 4). This outcome might be due to no colour addition to samples which influence the perception of panellists. From Table 5, the appearance and colour attributes results showed that 95% of panellist labelled sample "15 minutes cooking time and 0% xylitol" as "slightly like" (score 6) to "like very much" (score 9) with this sample arises highest score (Table 4). The lowest score for appearance attribute (6.32) is sample "20 minutes cooking time with 100% xylitol", and for colour attribute (6.68) is sample "20 minutes cooking time with 0% xylitol". Although the score are low for samples prepared at 20 minutes, but the percentage of panellist corresponded with "slightly like" to "like very much" were considered high with 72.5% (appearance) and 75% (colour).

The next two attributes; hardness and elasticity are the attributes that reflect properties. From hardness attribute, the panellists favour *dadih* sample with shorter cooking time (15 minutes) with score 7.2 for 0% xylitol and 6.73 for 100% xylitol. Similar results were reported for elasticity attribute which both samples with 0% and 100% xylitol at 15 minutes cooking time obtained higher score compared to samples prepared at 20 minutes of cooking time. *Dadih* that was prepared at 85˚C and 15 minutes produced softer *dadih*, which indicates the panellists fancied a softer *dadih*. Similar results can be observed from Table 5, which most panellist preferences (more than 80%) were on "slightly like" to "like very much" for sample of 15 minutes cooking time. Comparing the samples prepared at 15 minutes cooking time using 0% (total sucrose) and 100% xylitol (total xylitol), the outcomes showed that panellists were slightly preferred the samples with total sucrose. According to Winkelhausen *et al*. (2007) and Mushtaq *et al*. (2010), they stated that xylitol substitution into food product can alter the texture, make it more softer and tender.

Next sensory attributes focused on flavour characteristics which are taste and sweetness. To ensure consistency of the sweetness degree of *dadih* with sucrose and xylitol, all samples were tested with Brix Index test and the result showed all samples have the similar degree of sweetness (12.3± 0.01). Thus for both sensory attributes (taste and sweetness), the panellists had the highest preference (85% panellists)

**Table 4** Sensory evaluation score for four Dadih samples

| Sample | 15 min-0% | | 15 min-100% | | 20 min-0% | | 20 min-100% | |
|---|---|---|---|---|---|---|---|---|
| Sensory Attribute | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Appearance | 7.65 | 1.14 | 6.55 | 1.55 | 6.55 | 1.55 | 6.32 | 1.72 |
| Colour | 7.67 | 1.44 | 7.15 | 1.31 | 6.68 | 1.56 | 6.73 | 1.6 |
| Hardness | 7.2 | 1.6 | 6.73 | 1.83 | 5.89 | 1.91 | 5.5 | 2.1 |
| Elasticity | 6.93 | 1.44 | 6.63 | 1.56 | 5.75 | 1.94 | 5.65 | 2.08 |
| Taste | 6.98 | 1.76 | 6.58 | 1.82 | 6.05 | 1.74 | 5.33 | 2.09 |
| Sweetness | 6.88 | 1.92 | 6.4 | 1.97 | 6.13 | 1.79 | 5.5 | 2.05 |
| Overall acceptability | 6.88 | 1.83 | 6.3 | 1.96 | 5.73 | 1.81 | 5.3 | 2 |

Data is statistically not significant ($P > 0.05$)

**Table 5** Percentage (%) panellist corresponds to preferences for different attributes and samples

| | | Percentage (%) of panellist correspond | |
|---|---|---|---|
| Attribute | Sample | Dislike very much [1] to Neither like or dislike [5] | Slightly like [6] to Like very much [9] |
| Appearance | 15 min-0% | 5 | 95 |
| | 15 min-100% | 22.5 | 77.5 |
| | 20 min-0% | 27.5 | 72.5 |
| | 20 min-100% | 27.5 | 72.5 |
| Colour | 15 min-0% | 5 | 95 |
| | 15 min-100% | 10 | 90 |
| | 20 min-0% | 25 | 75 |
| | 20 min-100% | 22.5 | 80 |
| Hardness | 15 min-0% | 10 | 90 |
| | 15 min-100% | 20 | 80 |
| | 20 min-0% | 20 | 60 |
| | 20 min-100% | 45 | 42.5 |
| Elasticity | 15 min-0% | 7.5 | 92.5 |
| | 15 min-100% | 12.5 | 87.5 |
| | 20 min-0% | 40 | 60 |
| | 20 min-100% | 45 | 55 |
| Taste | 15 min-0% | 15 | 85 |
| | 15 min-100% | 25 | 75 |
| | 20 min-0% | 37.5 | 62.5 |
| | 20 min-100% | 47.5 | 52.5 |
| Sweetness | 15 min-0% | 15 | 85 |
| | 15 min-100% | 27.5 | 72.5 |
| | 20 min-0% | 17.5 | 72.5 |
| | 20 min-100% | 35 | 65 |
| Overall Acceptability | 15 min-0% | 15 | 85 |
| | 15 min-100% | 27.5 | 72.5 |
| | 20 min-0% | 40 | 55 |
| | 20 min-100% | 45 | 55 |

corresponded with “slightly like” to “like very much” towards sample “15 minutes cooking time and 0% xylitol” in comparison with the other three samples. However, the panellists still accepted the taste attributed to xylitol, as the second highest score with sample “15 minutes cooking time and 100% xylitol”.

For the last attribute, overall acceptability, there was no statistically significant difference between *dadih* samples for this attribute. This attribute would let the panellists to rank the sample in overall aspects of sensory input. Sample prepared at 15 minutes cooking time and 0% xylitol was the most favourite

with 85% of panellists labelled between "slightly like" to "like very much". Sample "15 minutes cooking time with 100% xylitol" as well as sample "20 minutes cooking time with 0% xylitol" were rank as second and third favourite, while sample "20 minutes cooking time with 100% xylitol" was the least preferred. From overall acceptability, the panellist rank the first and second choice of *dadih* samples from the same process condition (85˚C and at 15 minutes cooking time), although both of samples have different amount of xylitol substituted. The overall average scores of all samples were above 5, which meant that all samples definitely above 'like' categories in the hedonic score. The panellists still embraced the traditional concept of flavoursome *dadih* that using total sucrose. Despite with all the analysis, the score found for xylitol substituted *dadih* is consider promising since the samples made at 85˚C and 15 minutes of cooking time has shown the overall acceptability was above "slightly like" categories.

## Conclusion

Safety analysis is important to estimate the shelf life and to predict the product stability or quality. Based on TPC analysis, samples with low xylitol substitution were detected with microbial growth (small quantity) earlier than samples containing high xylitol substitution. The outcome of water activity analysis also supported the water activity result, which it achieved maximum values on Day 25. Finding for water activity was in agreement with TPC where day 25 recorded > 300 organisms per gram for all samples. Hence, *dadih* with high xylitol substitution has potentially to prolong the shelf life. From sensory analysis, the cooking time and composition of xylitol did influence the sensory attributes. *Dadih* sample prepared with shorter cooking time (15 minutes) was selected as the most favourite compared to samples cooked with longer cooking time (20 minutes). From the overall acceptability attributes, xylitol substituted *dadih* (100% xylitol) has the potential as promising product since more than 70% of the panellist ranked it between "slightly like" to "Like very much".

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