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## Analysis of Interrelations between Bottle Shape and Food Taste

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### 1. Introduction

#### 1.1 Background and motivation of research

Like human clothing, commercial package design helps to promote sales of a product. When consumers choose a product, they are easily attracted to the variable package design of products. While changes or improvement of graphic design can no longer fulfill the curiosity of consumers, variable form design must be applied to stimulate the buying incentive of consumers (Hsu 2002). Food packages are the commonest packages to consumers because food is the basic human necessity. The form design and visual design can be applied to attract consumer attention or stimulate the taste sensation of consumers. Most studies on the image of package form design thus investigated the differences between the visual design presentation of food contents and the perceiving results of consumers (Yang 2003; Shen 2000; Peng 1999; Do 1999; and Lin 1998). Lin (1998) investigated the synesthesia of taste and smell and located the matching principles and mixes of basic tastes and smells. This study has assumed that food package design must make consumers to effectively associate the package with food content, including the content and taste of food it contains. Therefore, to observe the shape of different food bottles and to categorize bottle shapes according to the taste of food they contain is the first motivation of this study.

Different form features give different feelings, emotions and images (Yang 2003). Secondly, the features and dimensions of food bottles on the market can influence the direct visual judgment of the product. Therefore, to investigate the form features and dimensions of food bottles is the second motivation of this study.

Taste stimulation stimulates people's feeling of tastes. Psychologists thus categorize tastes into 4 basic flavors: sour, sweet, bitter and savory flavors. In fact, no taste is independent. It often mingles with other feelings to reinforce the feeling of taste (Chang 1991). When presenting the product attributes with food packages, consumers associate them with the taste through visual perception and feeling of appetite. Therefore, to investigate how consumers associate tastes with the shape of food bottles is the third motivation of this study.



## 1.2 Objective of research

This study chiefly investigated the association between the shape of food bottles and the taste of food they contain in order to provide a reference for designers to make the right choice in food package design. The major objectives of research are as follows:

- (1) to classify the taste of food products on the market;
- (2) to analyze the features and dimensions of food bottle shapes; and
- (3) to investigate the association between food bottles and tastes.

## 2. Review of literature

### 2.1 Bottle shape design

Bottle form refers to the form of container designed to facilitate the consumption, safety and pleasant looking of food (Lin & Yang 2005). Bottles are the commonest food container (Yang 2001). The major difference between bottles and cans is the proportion of the mouth and body. Bottle containers often have a narrow mouth and bigger body, and can containers often have mouth and body of the same size, in a barrel shape. Therefore, the mouth and body are the distinctive features of bottle form.

A bottle is a container comprising a body, a mouth and a bottom (Chen-Chu 1995). In a study on the derivative and emotional images of container form, Pan (2004) classified the form of bottles into 4 elements: cover form, bottle height and width proportion, and the intersection angle of the bottle's shoulder and bottom. In a study on the emotional images of respondents according to the form of wine bottles, Lin (2003) classified the silhouette features of wine bottles into 4 sections: mouth, neck, body and bottom. According to Yang (2001), the angle of cutting is the major difference between a flat bottle mouth and a cut bottle mouth.

Therefore, the flatter the neck, the shorter the body; and the greater the cutting angle of the neck, the taller the body (Fig. 1). In this case, both the neck and the bottom are distinctive features in bottle form. Together with the cover and the body, they thus become the 4 distinctive features of bottle shape. While the neck can be connected to the body at different angles (Fig. 2), this study focuses on (a) the intersection angle of the neck and shoulder; (b) the location of mouth with reference to the body and the width of the bottom; and (c) the wide of the bottom.

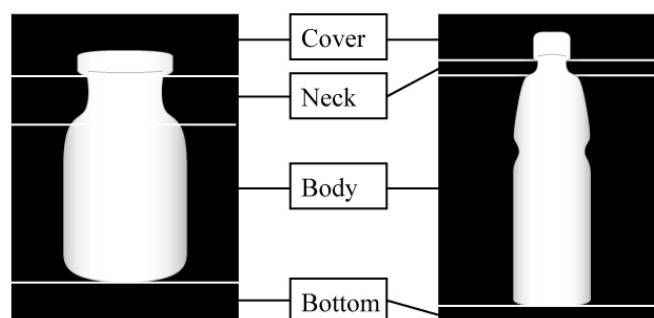


Fig. 1: Distinctive Features of Bottle Shape (this study)

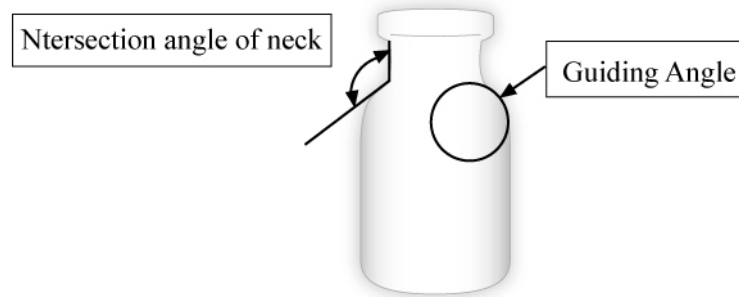


Fig. 2: Illustration of Intersection Angle of Neck and Shoulder (this study)

In bottle form design, changes in the shape and dimensions of any distinctive features can change the entire form of the bottle. The body can curve either inside or outside. When it curves inside, it is a concave bottle; and when it curves outside, it is a convex bottle. Fig. 3 shows the common shapes of bottles found on the market.

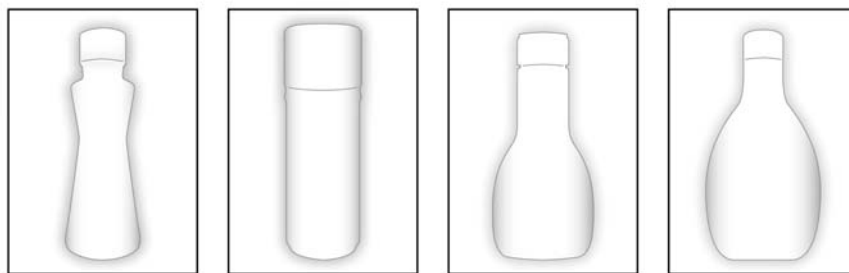


Fig. 3: Changes in Concave and Convex Bottles (this study)

The structure design of bottle form in order includes cover, neck, body and bottom. That is, designers can design each of them independently. According to Tovey (1989), right at the beginning of sketching a bottle to describe the overall *form features* of the bottle (Fig. 4a), designers will enlarge some features to elucidate their ideas visually (Fig. 4b). Later, they will present the exact size in sectional views (Fig. 4c).

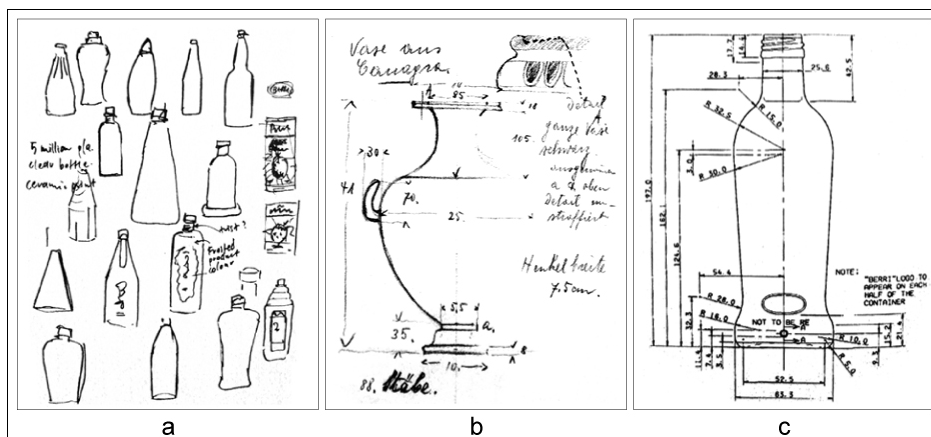


Fig. 4: Example of Bottle Design



## 2.2 Visual and taste perception

Vision is the major tool for human recognition of objects (Hong 1997). About 65% of human knowledge and experience are acquired from vision, and the visual system is the commonest organ for human contacts to external information (Lee 1992). The shape, color and material in form design can almost be sensed through vision (Yang 1997), suggesting that vision plays a more important role in understanding external information among all human sensory organs.

Taste is one of the 5 major human senses. The human taste receptor can feel 4 different tastes: sour, sweet, bitter and savory tastes. In fact, human taste often works with other senses in most cases to produce the synesthesia (Bailey 1989). Psychologists believe that tastes often mingle with other senses (Huang 2003). Therefore, the taste is never alone. When we speak of the color, the smell and the taste of food, we are making judgments with vision and taste. We identify the shape, color and quality with vision. Stimulating by the vision, we are motivated to taste the food. This process suggests that vision and taste are interdependent and synesthetic.

In the perceiving process of food choices, consumers can make judgment of the product contents and their taste according to the shape, size and color of the package. In fact, the variable package design is what attracts consumers most. Therefore, how to bring visual and smelling feelings to consumers by means of bottle form design, i.e. to associate taste according to visual stimulation, is the interest of this study.

## 2.3 Form and shape perception

Shape is one of the basic elements of form. From the viewpoint of form, *shape*, *color* and *quality feel* are basic elements of form.

The existence of form involves multiple sensory phenomena, chiefly including visualization, contact, mentality and physiology (Lin 1999). In his *Cognitive Psychology* (1990), Zhong mentioned that human cognition refers to the claimed familiarity with all forms. The process of familiarization involves sensation and perception. In the sensing process, the human brain receives messages from the sensory system, thus allowing us to receive messages of the environment. In the perceiving process, we decipher the meaning of messages (Sternberg 2002). Neither sensation nor perception is the feeling of a particular point but consecutive responses (Vim 1995). Therefore, people associate things with shapes according to perception. Likewise, perception experience also influences how people associate things with the shape.

Perception is feeling received from vision and promote or stimulate imagination (Lin 1993). The following perception model (Peng & Chang 1999) can effectively describe the interrelations of elements of human perception of bottle form. Fig. 5 shows the respondent's perception processing of bottle form, including perceiving the shape and size of the bottle with the visual system, thinking and memorizing shape messages relating to the said visual feelings, and controlling the psychological judgment of the bottle form. Lastly, the legibility of associating the bottle form with the taste arises.

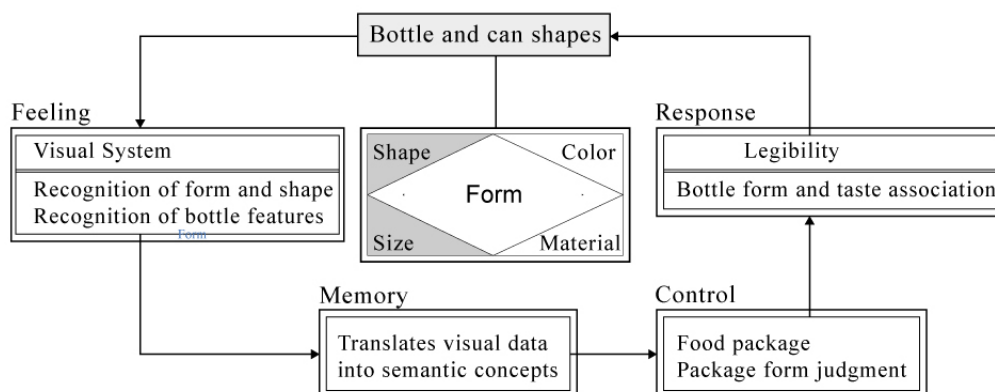


Fig. 5: Form Cognition Model (this study)

### 3. Methods of research

Literature review and survey were applied to this study. First, food bottle samples were collected from the market and the tastes of food were classified according to the bottle forms. Then the perception experiment was conducted to investigate the food bottle shape and food taste association.

#### 3.1 Collection of samples

A total of 191 samples were collected from the food products sold in hypermarkets and supermarkets in Taiwan (including RT-Mart, Carrefour, Géant, and Welcome) and line-sketched (Fig. 6).



Fig. 6: Processing of samples

Sixty-one kinds of foods and tastes were selected, including vinegar (sour), sugar (sweet), oolong tea (bitter), salt (savory), soy sauce (savory), chilly oil (spicy), yogurt milk (sweet and sour), fruit juice (sweet and sour), steak sauce (savory and sour), peanut butter (sweet and savory), sweet and spicy sauce (sweet and spicy), chilly sauce (spicy and savory), pepper powder (spicy and savory), kimchi (savory and sour and spicy), tomato sauce (savory and sweet and sour), mayonnaise (savory and sweet and sour), green tea (sweet and bitter), and coffee (sweet and bitter) and were categorized by taste.

#### 3.2 Subject of research

Basic requirements of respondents are similar age, similar life experience and education attainment. To ensure the validity of perception association survey, 20 respondents with design background were selected from undergraduate and postgraduate students at age between 18 and 25.



### 3.3 Environment and tool of research

The experiment was conducted in a closed and quiet environment to ensure that respondents were free from external interference. After explaining the contents and procedures of experiment, drawings were distributed to them for the experiment.

### 3.4 Design of taste association experiment

#### 3.4.1 Selection and filtering of respondents

All 191 food bottle samples collected were presented in bottle form cards. As there were too many samples and they were basically similar in form, a focus team was formed at this stage to select 100 samples for the experiment through interviews and discussions, and each sample was numbered.

Cards of 13 tastes were also prepared to facilitate respondents to associate them with the bottle form cards. The size of cards is 5x5cm.

#### 3.4.2 Formation of focus group

Members of the focus group must have basic training in design and at least 5 years of practical experience in related fields. Four members were selected to help filtering the samples through discussions under the assistance of the researcher.

#### 3.4.3 Experiment procedures

All 13 taste cards were laid on the table in front of the respondents who were asked to associate them with 100 bottle form cards. Respondents were asked to first categorize bottle forms with the same taste, and second to select and sort 3 bottle forms that can best represent each taste. After the selection, bottle form cards in each category were numbered (Fig. 7).

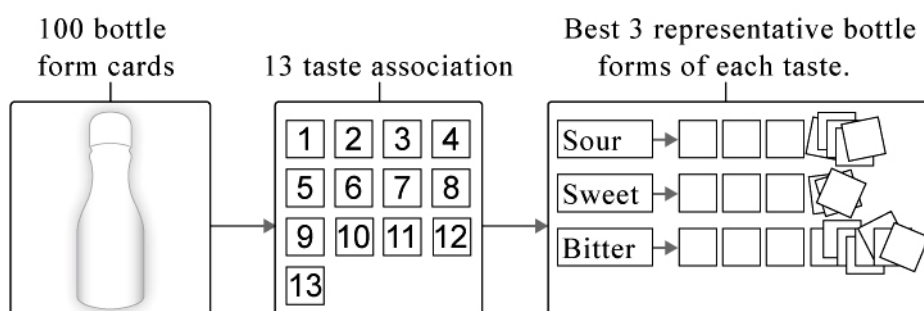


Fig. 7: Experiment Procedures of Taste Association

### 3.5 Limit of research

- (1) Samples with handles were excluded for status observation. Contents of food did not include alcoholic drinks, food medications and pure water.
- (2) The experiment focused only on the taste association according to the shape of food bottles. The color, quality feeling and size of food bottles were thus not considered in the experiment.
- (3) The sample design control of these conditions was a constant.



(4) In consideration of the manpower and material, samples of bottle form and taste association were presented in cards instead of true bottles.

#### 4. Results and analysis

##### 4.1 Observation and record of food bottle form

According to market observation, the 4 distinctive features of food bottles are: cover, bottle, body and bottom; and changes in any of these features will change the entire form of the bottle.

The *cover* (Fig. 8a) refers to any object used to cover up the mouth of the bottle, i.e. the *mouth* in the related literature. The *neck* is located between under the *cover* and above the *shoulder*, forming an intersection angle. As it functions like a connector, there is an intersection angle (Fig. 8b). The *body* refers to the section under the *neck* and above the *bottom* (Fig. 8c). The *bottom* is located at the lowest part of the entire bottle and contacts with the surface where the bottle is placed (8d).

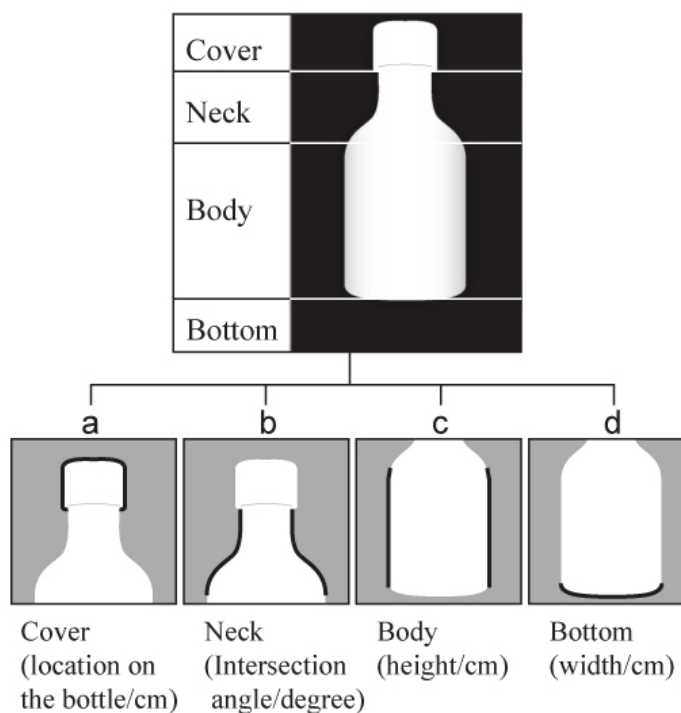


Fig. 8: Changes in distinctive features of bottle shale (this study)

The 4 distinctive features of bottle form were recorded in different sizes, including cover location, neck intersection angle, body height, and bottom width. According to the observation of all 191 samples, the cover of most samples is located at 1.6-2.5cm of the bottle, so it was applied to all 100 samples used in the experiment, and its size is about 39% of the entire bottle (Table 1). The intersection angle of the neck is 151°-180° (38% of the entire bottle); the body height is 6-10cm (37% of the entire bottle) and the bottom width is 6-10.9cm (72% of the entire bottle).



**Table 1:** Survey on the Actual Sizes of Bottle Form Features

4 distinctive features of bottles	Size	Percentage
Cover (location on the bottle/cm)	0.1-0.9cm	35%
	1.1-1.5cm	21%
	<b>1.6-2.5cm</b>	<b>39%</b>
	2.6cm and up	5%
Neck (Intersection angle/degree)	90°	3%
	91-120°	22%
	121-150°	37%
	<b>151-180°</b>	<b>38%</b>
Body (height/cm)	<b>6-10.9cm</b>	<b>37%</b>
	11-15.9cm	22%
	16-20.9cm	30%
	21-25.9cm	11%
Bottom (width/cm)	3-5.9cm	27%
	<b>6-10.9cm</b>	<b>72%</b>
	11-15.9cm	1%
	16cm and up	0%

#### 4.2 Taste classification of food bottle form

The taste of food contents of samples was divided into 2 types: single taste and mixed taste (2 or more tastes). The 5 single tastes included: sour, sweet, bitter, savory and spicy tastes; and the 8 mixed tastes included: sweet and sour, savory and sour, sweet and savory, savory and spicy, savory and sour and spicy, savory and sweet and sour, and sweet and bitter tastes; altogether 13 tastes.

Table 2 shows the percentage of tastes of all 191 samples. Results indicated that the savory taste is the majority, sharing 29% of the total; the sweet and sour taste is the second, sharing 25%; the spicy and savory is the third, sharing 18%; and the spicy, sweet and spicy, and bitter tastes are the lowest, each sharing 1%.

**Table 2:** Food Content Taste Percentage

Taste	<b>Savory</b>	<b>Sweet +Sour</b>	<b>Spicy +Savory</b>	Sweet +Savory	Savory +Sweet +Sour	Sweet	Savory +Sour +Spicy
Percentage	<b>29%</b>	<b>25%</b>	<b>18%</b>	5%	5%	4%	4%
Taste	Sour +Savory	Bitter	Sweet +Bitter	<b>Bitter</b>	<b>Spicy</b>	<b>Sweet +Spicy</b>	
Percentage	3%	2%	2%	<b>1%</b>	<b>1%</b>	<b>1%</b>	

#### 4.3 Food bottle form and food taste association survey

According to the experiment results, the *sweet taste* is the commonest choice of respondents, sharing 15%; the *sweet and sour taste* is the second, sharing 14%; and the *savory taste* is the third, sharing 11%. The least selected tastes are *savory+sour+spicy* and the *savory+sweet+sour* tastes, each sharing 4%; and the *sweet+bitter taste* is the second lowest, sharing 5%(Table 3).

**Table 3:** Bottle Form and 13 Tastes Association Survey





Taste	<b>Sweet</b>	<b>Sweet +Sour</b>	<b>Savory</b>	Sour	Spicy +Savory	Sweet +Spicy	Bitter
Percentage	<b>15%</b>	<b>14%</b>	<b>11%</b>	8%	8%	7%	6%
Taste	Spicy	Sour +Savory	Sweet +Savory	<b>Sweet +Bitter</b>	<b>Savory +Sour +Spicy</b>	<b>Savory +Sweet +Sour</b>	
Percentage	6%	6%	6%	<b>5%</b>	<b>4%</b>	<b>4%</b>	

These results indicate that 2 of the top 3 associated tastes are single tastes; and all 3 least associated tastes are mixed tastes. These also suggest that it is easier for respondents to associate a bottle form with a single taste, and it is more difficult for them to associate a bottle form with a mixed taste.

Table 4 shows the percentage of association between bottle form and single taste. Results indicate that the *sweet taste* is the commonest associated single taste, sharing 30%; and the *savory taste* is the second, sharing 24%. These also suggest that respondents believe that most bottles are designed for containing *sweet* foods, and the least bottles are for *bitter* foods.

**Table 4:** Bottle Form and Single Taste Association

Taste	Sour	<b>Sweet</b>	<b>Bitter</b>	Savory	Spicy
Percentage	19%	<b>30%</b>	<b>13%</b>	24%	14%

Table 5 shows the percentage of association between bottle form and mixed taste. Results indicate that the *sour+sweet taste* is the commonest associated single taste, sharing 26%, suggesting that the *sour+sweet taste* is the commonest mixed taste. The percentage the *savory+sour+spicy taste* and *savory+sweet+sour taste* is the lowest, each sharing 8%, suggesting that bottles for containing foods of these tastes are the least.

**Table 5:** Bottle Form and Mixed Taste Association

Taste	<b>Sweet +Sour</b>		Sour +Savory		Sweet +Savory	Sweet +Spicy	Spicy +Savory
Percentage	<b>26%</b>		11%		11%	13%	14%
Taste	<b>Savory +Spicy</b>	<b>+Sour</b>	<b>Savory +Sour</b>	<b>+Sweet</b>	Sweet +Bitter		
Percentage	<b>8%</b>		<b>8%</b>		9%		

At the association stage of the experiment, respondents were allowed to associate the taste of food with the bottle containing it. Table 6 shows the results of the experiment. The *sour*, *spicy*, *sweet+savory*, *sweet+spicy*, *savory+sour+spicy*, and *sweet+bitter tastes* allow respondents to associate with bottles of *similar features* in the form. Results indicated:

#### • Sour

Most respondents associated bottles with a smaller cover (short diameter) and long and narrow body with the sour taste; i.e. bottles containing sour foods allow respondents to associate with bottle forms of *similar features*.



**Spicy**

Most respondents associated bottles with a smaller cover (short diameter) and long and narrow shape with the spicy taste; i.e. bottles containing spicy foods allow respondents to associate with bottle forms of *similar features*.

**Sweet+savory taste**

Most respondents associated bottles whose cover and body are wider (longer diameter) and body is shorter with the taste; i.e. bottles containing sweet+savory foods allow respondents to associate with bottle forms of *similar features*.

**Sweet+sour taste**

Most respondents associated bottles with a smaller cover (short diameter) and long and narrow shape with the sweet+sour taste; i.e. bottles containing sweet+sour foods allow respondents to associate with bottle forms of *similar features*.

**Savory+sour+spicy taste**

Most respondents associated bottles whose cover and body are wider and body is shorter with the taste; i.e. bottles containing savory+sour+spicy foods allow respondents to associate with bottle forms of *similar features*.

**Sweet+bitter taste**

Most respondents associated bottles whose cover and body are bigger, mostly in a barrel shape, with the taste; i.e. bottles containing sweet+bitter foods allow respondents to associate with bottle forms of *similar features*.

**Table 6:** Taste and Bottle Form Association Results

Taste	Analysis
Sour	1
	2
	3
Spicy	1
	2
	3





(3) Observation of the features of food bottles indicates that the mouth, the neck, the body and the bottom are the 4 distinctive features of food bottles. Changes in any of these distinctive features can change the entire bottle form. The commonest sizes of food bottles on the market are: the cover is located at 1.6-2.5cm of the bottle; the intersection angle of the neck is 151°-180°; the body height is 6-10cm; and the bottom width is 6-10.9cm.

(4) Results of the bottle form and food taste association experiment indicate, bottles for containing sweet foods are the commonest; while bottles for containing *savory+sour+spicy* and *savory+sweet+sour* foods are the least on the market. Secondly, it is difficult for respondents to associate a bottle form with mixed taste foods, suggesting that it is easier to for respondents associate a bottle form with single taste foods than mixed taste foods.

(5) Besides the fact that respondents can associate *sour*, *spicy*, *sweet+savory*, *sweet+spicy*, *savory+sour+spicy*, and *sweet+bitter* foods with bottle forms of *similar features*, it suggests that the judgment of these tastes and bottle forms of respondents is consistent. Bottles with a smaller mouth and taller and narrower body allow respondents to associate to *sour*, *spicy* and *sweet+spicy* foods. Bottles with a wider mouth and body, and a shorter or barrel-shaped body allow respondents to associate to *sweet+savory*, *savory+sour+spicy*, and *sweet+bitter* foods.

To allow consumers correctly associate the bottle form with the content and its taste the bottle contains is the mission of food package design. This study aims at investigating the form and taste association of food bottles. The 4 distinctive features of bottle form are the cover, the neck, the body and the bottom. Besides the height and width of the 4 distinctive features of bottle form: cover, the neck, the body and the bottom, changes in the radius (arch) of the guiding angle can influence the development of bottle form development. Due to the limit of manpower and material, investigations of such changes were not included in this study. Furthermore, subsequent studies may focus on the associations between the color, quality feel and size of bottles and taste because they are factors relating to bottle form.



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