Journal of Engineering and Applied Sciences 12 (Special Issue 5): 7082-7086, 2017
ISSN: 1816-949X

Development of Disposable Shaking-Cup by Laser Cutting Device and Comparing the Performance of Various Designs of Shaking-Cup Strainers

Jun Ho Kwon
School of Design, Seo Won University, 377-3 Musimseoro, Heungdeok-gu,
Cheongju, 361-742 Chungbuk, South Korea

Abstract: The current study aims to compare and analyze the performance of various shaking-cup strainer designs in order to improve the accessibility and cost-efficiency of shaking-cup which can be used readily with the final goal of developing the most effective disposable shaking-cup. As for the methodology, the study begins with comparing the performance of shaking-cup strainer designs, including spring-vertical movement design, integrated cover design, integrated swirler design and spring ball design in order to find the optimal form of the strainer. Next, the study goes on to design and develop paper strainer that can be attached to disposable paper shaking-cup using the optimal strainer design found in the previous study. The results of the analysis found that the integrated swirler design is most efficient, followed by spring ball type, spring-vertical movement type and integrated cover type. Three-wing propeller design was used to develop the most effective strainer for disposable shaking-cup by considering the thickness and durability of the study material which resulted in hard and high-performing disposable shaking-cup.

Key words: Strainer design, disposable, shaking-cup, propeller type, swirler-type, study

INTRODUCTION

With an increased popular interest in health and weight loss diet in the contemporary society, young Korean men are purchasing more protein shake products. A survey conducted from January-March in 2015 showed that sales for protein shake products increased by 59% in that period, quantitatively proving the rapid rise in the demand for the health supplement. In addition, the market for the product is diversifying with various functions including added protein component, lower fat content as well as more varied types and performance results (Sik, 2000).

Thanks to the newfound popularity in protein shake products, shaking-cup sales are on the rise as well, showing an increase by 65% in 2013 compared to the previous year. In particular, online shopping mall G-market reported shaking cup sales growth of 50% and cafe chain Starbucks is selling 70 billion Korean won of the product yearly as of October, 2016.

Shaking-cup was invented in 1865 to mix cocktail drinks. It can be used to easily mix not only cocktails but also protein shake and other various powder-based beverage products. The cups are primarily manufactured with metals such as nickel silver, gilded silver and stainless metal but there are glass and plastic shaking-cups in the market as well. Shaking-cup is composed of three parts, cap, strainer and body. The user puts in ice and drink ingredients into the body of shaking-cup before closing the strainer and the cap to mix the contents. After the drink is mixed, only the cap is opened to pour in the liquid into another glass through the strainer. Some shakers do not have an attached strainer such as Boston type shaker. Shaking-cups are configured with detachable parts that can be separated into two or three components while others feature integrated parts. The strainer in shaking-cups work to help the beverage mix in without the contents from forming cakes and the scales shown on the outside of the cup body allows the user to check the precise volume of the liquid.

Despite, the fact that various designs of shaking-cup and its strainer are available, little to no research has been conducted in order to find out strainers with which design are more high-performing in terms of the function. The evolution of the contemporary society is bringing in rapid changes of trend and confluence of information that is causing the contact between various forms of communication and convergence of different designs (Eun, 2010). As such the demand for unique design and functionality that can provide added value and entertainment in life is increasing (Gyo-Jun, 2015). In addition, advances in technology is pushing consumers to require decorative, economic and functional features as

opposed to unidimensional features in their products which must perform complex and multidimensional purposes (Won, 2007).

With this, the consumer demand is quickly shifting to require powder-based beverages such as protein shake, fruit soju cocktail, cocktail and grain powder beverages to be more readily available in places such as convenience stores. As such there is a need to develop disposable shaking-cup that includes a paper strainer. In order to meet such requirements, the current study seeks to develop a disposable shaking-cup strainer to provide consumers with improved accessibility and convenience in addition to enhancing the cost and design efficiency as well as durability of such paper strainer by design (Won, 2012). The current study first aims to compare and analyze the performance of various shaking-cup strainer types including spring-vertical movement design, integrated cover design, integrated swirler design and spring ball design in order to find the optimal form of shaking-cup strainer. Next, based on the type of strainer found in the previous study, paper strainer designs that can be applied to disposable paper shaking-cup are developed. In addition, an analysis is conducted to find the most effective shaking-cup design (Hae, 2010).

In order to achieve the goals of the research, the following research questions were established:

- Among the four shaking-cup strainer types which design displays the best performance?
- What is the most effective design among the paper shaking-cups developed through the current study?

Development of disposable shaking-cup strainer design: Based on the comparison conducted on the performance of shaking-cups that are already developed and in circulation in the market, the current study designed the most effective disposable shaking-cup. That is based on the advantages of integrated swirler design type, shaker components were attached inside of small 13 ounce disposable paper cups to design four disposable shaking-cup strainers as shown in Fig. 1.

In designing the disposable shaking-cup strainers, the current study seeks observe the opinion in (Seul-Gi, 2016) which argues to minimize paper use to reduce waste of resources and environmental design and ecology design. It is aimed to maintain the nature and provided a new value to the environment issue (Kim *et al*., 2016) while simplifying the manufacturing process by not using glue to decrease burden on the natural environment. Shaking-cup strainer designs all take basic propeller-type form with different number of wings on the propeller from 3-6. Furthermore, in order to compare the functional performance of the strainers, the area of the propeller wings were differentiated into four sizes.

Fig. 1: Five disposable shaking-cup designs

MATERIALS AND METHODS

Tools of measurement

Shaking-cup strainer: The research went on to conduct an experiment to compare the performance of four different shaking-cup strainer designs as shown in Table 1.

Disposable shaking-cup strainer: The current study compares the performance of four different disposable shaking-cup strainers. The following are the features of each type of strainer in Table 2:

Research procedures

Comparison of performances based on shaking-cup strainer design: In order to compare the performance depending on shaking-cup strainer designs, 300 mL of milk and 32 g of protein powder were put into a the four types of shaking-cup to conduct an experiment under the following procedures. The objective criteria in the experiment are as follows: First, the same amount of milk in the same temperature was used for all cups. Second, the same posture and speed were maintained while shaking each shaking-cup ten times up and down in the same method. Third, the size and volume of powder cake strained by the strainer were measured with a scale.

Performance comparison based on the disposable shaking-cup strainer design: In order to compare the performance depending on the design of disposable shaking-cup strainer created through this study, 300 mL of milk and 32 g of protein powder were put into a the four types of disposable shaking-cup to conduct an experiment under the following procedures. The objective criteria in the experiment were the same as those of experiment for shaking-cup strainers.

Table 1: Features of various shaking-cup strainer designs

Types	Images	Features
Spring-vertical movement type (timmer powder shaker water bottle)		A stainless spring moves vertically when the bottle is shaken, in order to help the powder mix into the liquid via. mechanical function
Integrated cover type (Smart shake original)		A strainer with a concave form is attached to the cover with a hexagonal hole in it
Integrated swirler type (Deco jet shaker)		While there is no separate strainer, the bottom of the cover and the bottom of the bottle are screw-shaped, providing an integrated-type straining function
Spring ball type (Blender bottle sports strainer)		Strainer is in a ball shape within a stainless spring, moving freely inside of the bottle while it is shaken

Table 2: Performance comparison based on the disposable shaking-cup strainer design

Types	Images	Features
3-wing propeller		With 3 propeller wings, this type has the largest wing area of all designs
4-wing propeller		With 4 propeller wings, this type has the second largest wing area of all designs
5-wing propeller		With 5 propeller wings,this type has the third largest wing area of all designs
6-wing propeller area		With 6 propeller wings, this type has fourth largest wing of all designs

RESULTS AND DISCUSSION

Comparison of shaking-cup strainer performance based on their design: Table 3 shows the result of performance of the four shaking-cup strainers based on their design. As shown in Table 3, the integrated swirlertype strainer (deco jet shaker) had the highest mixing performance with only 1.5 g of remaining powder cake, followed by spring ball type with 3 g of remainder, spring-vertical movement with 4.3 g and integrated cover type with 7 g. This result

shows how the propeller turbulence helps to mix powder strongly and it caused by "tipvortex cavitation". Tip vortex cavitationis one among the types of cavitation around propeller wings which occurs at blade tip and hub. Usually, occurs near blade tip and hub (Patil *et al*., 2016).

Comparison of disposable shaking-cup strainer performance based on their design: Table 4 shows the results of comparison among the four disposable shaking-cup strainer types in terms of their mixing performance.

Table 3: Comparison of shaking-cup strainer performance based on their design

Type/Product name	Images	Filtered product image	Remaining powder cake (g)
Spring-vertical movement type (Trimmer powder shaker water bottle)			4.3
Integrated cover type (Smart shake original)			7
Integrated swirler type (Deco jet shaker)			1.5
Spring ball type (Blender bottle sports strainer)			3

Table 4: Comparison of disposable shaking-cup strainer performance based on their design

Types	Images	Strained image	Remaining powder cake (g)
3-wing propeller type			4
4-wing propeller type			7
5-wing propeller type			10
6-wing propeller type			8

As shown in Table 4, the 3 wing propeller type strainer was found to have the highest performance with only 4 g of remaining powder cake, followed by 4 wing propeller type with 7 g of remainder, 6 wing type with 8 g and 5 wing type with 10 g.

In order to design a strainer with the highest functional performance based on their form and type, the current study compared the effectiveness of four shaking-cup bottles in circulation in the market. Based on the optical form of strainer, the research went on the develop a design for paper strainer that can be attached to disposable shaking-cups. In addition, among the developed four shaking-cup strainer designs, the study went on to analyze the most effective form for mixing powder and liquids.

First, the comparison of performance based on the design of shaking-cup strainer, integrated swirler-type was found to have the highest mixing capability, followed by spring ball type, spring-vertical movement type and integrated cover type. Because of the thin wire used to make the spring it may have not been effective in mixing the contents of the bottle. In addition, the results showed that the widely-used integrated cover type strainer bottle is the most ineffective in mixing performance. In contrast, integrated swirler-type mixing bottles are designed to make the contents to hit the lid and the bottom of the bottle which forces them to revolve in the form of the strainer, making it the most effective in mixing the powder into liquids. Such research results may be actively used to develop designs for shaking-cup strainers which will allow the manufacturers to develop more effective and convenient shaking-cups for consumers. Furthermore, in order to design a more objective and reliable experiment, future research may study the performance of different strainers attached to the widely used but poor efficiency integrated cover type shaking-cups such as hexagon, propeller, concave propeller and double propeller shapes.

Second, the performance comparison of disposable shaking-cup strainers developed in the current study showed that the 3 wing propeller type strainer had the most effective mixing capabilities, followed by 4 wing type strainer, 6 wing type strainer and 5 wing type strainer.

CONCLUSION

This indicates that the size of the propeller wings play an important role in mixing in the powder while the number of the wings do not influence the results as much. Such a result is meaningful in that under the current market condition in which disposable strainer cup products are not available, disposable paper strainers may be developed to be attached to disposable cups to allow consumers to access protein shake and other powder-based beverages in places like convenient stores, fitness clubs and vending machines, at lower costs.

RECOMMENDATIONS

As such future research go on to conduct experiments that compare the performance of propeller-type strainers with different wing quantities, wing heights, wing angles and other factors in order to develop a design with optimal conditions for disposable shaking-cup strainer products.

REFERENCES

Eun, K.N., 2010. A comparative analysis on the can coffee package design between Korea and Japan, in view of on the Brand positioning. Master Thesis, Chosun University, Gwangju, South Korea.

Gyo-Jun, H., 2015. A study on the design development of a paper cup on using graphic wit. Master Thesis, Hankyong National University, Anseong, South Korea.

Hae, L.E., 2010. Research on the crockery product expressing the image of connection: For the design of grab on the cup. Master Thesis, Kyung Hee University, Seoul, South Korea.

Kim, K., D.S. Lee and Y.C. Kim, 2016. Sustainable design process based on 3D printing technology. Indian J. Sci. Technol., 9: 1-2.

Patil, V., H.R. Purushothama, A. Manjunatha and V.K. Mishra, 2016. Performance evaluation of marine propeller using numerical simulation. Indian J. Sci. Technol., 9: 1-2.

Seul-Gi, P., 2016. A study on the environment-friendly cup carrier design to reduce material usage. Master Thesis, Hongik University, Seoul, South Korea.

Sik, K.Y., 2000. Effect of taking protein supplements on the bodily structure and muscular function in the weight training. Master Thesis, Keimyung University, Daegu, South Korea.

Won, M.Y., 2012. A study on the reduction and status of packaging waste: Focused on development of cup ramen container structure design. Master Thesis, Hanyang University, Seoul, South Korea.

Won, S.J., 2007. A study on the design about cup-holder that was applied repeated shape with section image of mandarine. Master Thesis, Seoul National University, Seoul, South Korea.