

# “Thickened Beverage Vending Machine” In-Cup Mixing Automatic Tea Server

KUROYANAGI, Yasuhiko\* KIDA, Akira\* OZAWA, Tatsunori\*

## ABSTRACT

As the population of Japan continues to age, there is a need to address labor shortages and improve the working environment in the nursing care field. Fuji Electric has launched the “Thickened Beverage Vending Machine,” which facilitates the preparation of thickened beverages using the technology it has cultivated in cup vending machines and other products. Thickened beverages have more viscosity than usual to prevent aspiration, that is, accidental entry of food or drink into the trachea. In the medical and nursing care field, the viscosity must be varied depending on the condition of each individual care receiver by hand, placing a burden on the caregivers. Our newly developed Thickened Tea Vending Machine can automatically adjust the beverage temperature and viscosity according to the care receiver.

## 1. Introduction

The number of people in need of nursing care continues to increase as the birthrate in Japanese society declines and the population ages, making it an urgent social issue to eliminate labor shortages and improve the working environment at nursing care sites. For example, when caring for people with difficulty swallowing, measures need to be taken to thicken meals and drinks to prevent aspiration. This creates a heavy burden on caregivers because the work is cumbersome and requires careful attention. To help solve this problem, Fuji Electric has developed and released the “Thickened Beverage Vending Machine” that can easily serve thickened beverages optimally suited for each person requiring nursing care by utilizing technology cultivated in vending machines.

## 2. Development Background and Challenges

### 2.1 Thickened beverages

Thickened beverages have more viscosity than usual. In order to prevent elderly people and other patients with weakened throat functions from aspiration and choking, we are supplying this product to medical institutions, long-term care facilities, senior citizen housing facilities, and nursing homes. Adding a little viscosity to a beverage slows the rate at which it passes down the throat and thus helps prevent aspiration. This viscosity should be changed according to the condition of the person requiring care. In addition, temperature control is also important because thickened beverages take time to pass through the throat and may cause burns if the temperature is too high.

Currently, thickened beverages are made by hand by caregivers such as hospital staff. In order to prepare a thickened beverage of the quality (viscosity and temperature) suitable for each person requiring nursing care, careful measuring of ingredients and lengthy stirring are required, placing a heavy burden on caregivers.

### 2.2 Challenges in developing the “Thickened Beverage Vending Machine”

There are some challenges to developing the Thickened Beverage Vending Machine, as described below. Table 1 shows the challenges and corresponding solutions for the Thickened Beverage Vending

Table 1 “Thickened Beverage Vending Machine” development challenges and corresponding functionalities

| User           | User needs                                    | Corresponding challenges                                 |  | Function   |
|----------------|---|--|--|--|
| Care receivers | Provide suitable beverages for care receivers | Preparation according to the condition of care receivers | Adjustable to a prescribed viscosity   | Precise weighing and blending                                |
|                |   |  | Uniform mixing, no residue             | In-cup mixing, shaking control                               |
|                |   |  | Adjustable to a prescribed temperature | Controlling the temperature and amount of cold and hot water |
| Caregivers     | Can make drinks easily and reliably           | Automation of beverage preparation                       |  | Automated preparation using buttons                          |
|                |   | Prevents operation errors                                |  | Selection guide function                                     |
|                | Easy clean up after preparation               | Ensures sanitation                                       |  | Automatic cleaning (New propeller system)                    |

\* Food & Beverage Distribution Business Group, Fuji Electric Co., Ltd.

Machine.

- (1) Preparation according to the condition of the person requiring care

Care receivers need thickened beverages that have a suitable viscosity, uniform composition with ingredients completely dissolved, and a suitable temperature.

The Japanese Society of Dysphagia Rehabilitation has established three levels of criteria for thickened beverages, depending on the degree of dysphagia. The Thickened Beverage Vending Machine is also required to comply with this criteria.

Temperature control is also important for preparing properly thickened beverages. Interviews with medical professionals and raw material manufacturers showed that a temperature of approximately 45°C is desirable for hot beverages. At the same time, it is also important to consider how to prepare and control the temperature of cold beverages.

Another need for care receivers is to be able to drink thickened beverages at the right time without waiting. Therefore, another challenge is to reduce the preparation time of the Thickened Beverage Vending machine so that it is faster than preparing beverages by hand.

- (2) Ease of use

Caregivers are responsible for operating the Thickened Beverage Vending Machine to serve care receivers thickened beverages. Therefore, another challenge is to improve the ease of use of the Thickened Beverage Vending Machine. Conventional tea vending machines are designed for convenience, offering users a one-touch selection of beverages by just pressing a button. However, in the case of the Thickened Beverage Vending Machine, if the wrong button is pressed, it could dispense a beverage with the wrong viscosity. If this beverage was served to a care receiver, it could lead to aspiration. Therefore, the most important requirement is to be designed so that operators can select the thickening agent being added or not and thickening viscosity without fail.

- (3) Ensuring sanitation

Sanitation control is essential for caregivers in hospitals and nursing homes who are responsible for managing the Thickened Beverage Vending Machines, since the thickened beverages are consumed by the elderly and handicapped. Therefore, desirable products can perform stable and easy automatic cleaning without the need of cleaning equipment. To reduce the burden on caregivers, the product needed to be sanitary in daily operations and not time-consuming to maintain.

### 3. “Thickened Beverage Vending Machine”

#### 3.1 Product overview

Figure 1 shows the external appearance and internal structure of the Thickened Beverage Vending Machine, and Table 2 shows its specifications.

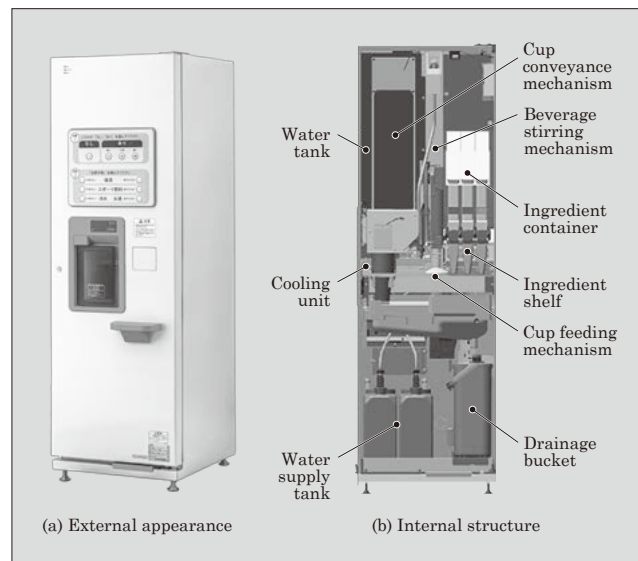


Fig.1 External appearance and internal structure of the “Thickened Beverage Vending Machine”

Table 2 Specifications of the “Thickened Beverage Vending Machine”

| Item                          | Specification                                     |
|-------------------------------|---|
| Dimensions                    | W550 × D605 × H1,700 (mm)                         |
| Type of sales                 | Hot beverages × 3, Cold beverages × 3             |
| Function buttons              | 4 (3 levels of thickness, None)                   |
| Ingredient capacity           | 2.4 L × 3 (Thickener × 1, Powder × 2)             |
| Ingredient preparation method | In-cup mixing system                              |
| Cup mechanism                 | Yes (9 oz)  |
| Cup capacity                  | 1 type 2 rows (200 or more)                       |
| Cup conveyance system         | X-axis conveyance system                          |
| Heating unit                  | Capacity 7 L, Heater 550 W                        |
| Cooling unit                  | Water tank 4.5 L (ice bank system)                |
| Water supply system           | Direct tap water connection, Cassette tank system |
| Refrigerant                   | R1234yf   |
| Power supply                  | 100 V, 50/60 Hz, 15 A                             |

#### 3.2 Features

- (1) Control parameters to ensure high quality beverages

We collaborated with raw material manufacturers who are experts in thickening agents and identified control parameters for handling thickening agents. Table 3 shows the characteristics and control parameters of the thickening agents.

Based on our understanding of the characteristics of thickening agents, we identified the conditions necessary to provide thickened beverages with three levels of viscosity by referring to the viscosity criteria established by the Japanese Society of Dysphagia Rehabilitation (see Fig. 2) and reflected the conditions in the thickened beverage vending machine.

- (2) Automation of preparation process

Table 3 Characteristics and control parameters of thickening agents

| Characteristics of thickening agents | Control parameter                             |
|--------------------------------------|---|
| Solubility                           | Hot and cold water temperature, Stirring time |
| Viscosity change                     | Stirring time, Standing time                  |
| Viscosity effect                     | Ingredients, Cold water, Hot water slowing    |
| Temperature dependence               | Beverage temperature and standing time        |
| Stickiness                           | Sanitation (rinse water volume, timing)       |

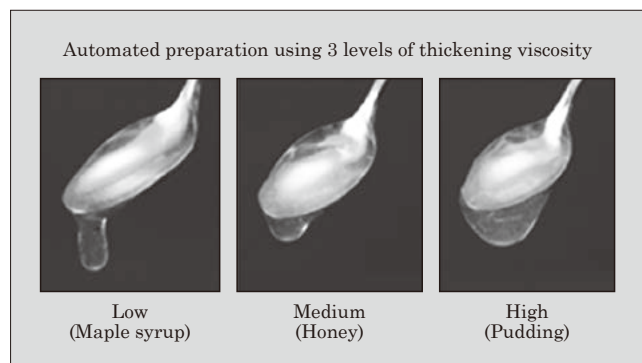


Fig.2 Viscosity criteria<sup>(1)</sup>

Figure 3 shows the preparation process. This is the first automatic tea server to use the in-cup mixing system utilized by cup-type vending machines. Figure 4 shows the in-cup mixing system. This system prepares beverages by using a propeller to stir the ingredients and hot or cold water inside the cup. This is a cutting-edge technology for preparing beverages that allows the position, number of revolutions, and time to be optimized to the characteristics of the ingredients, such as particle size and viscosity. Furthermore, by adding a side-to-side shaking motion to the cup during stirring to increase stirring efficiency, it can prepare a

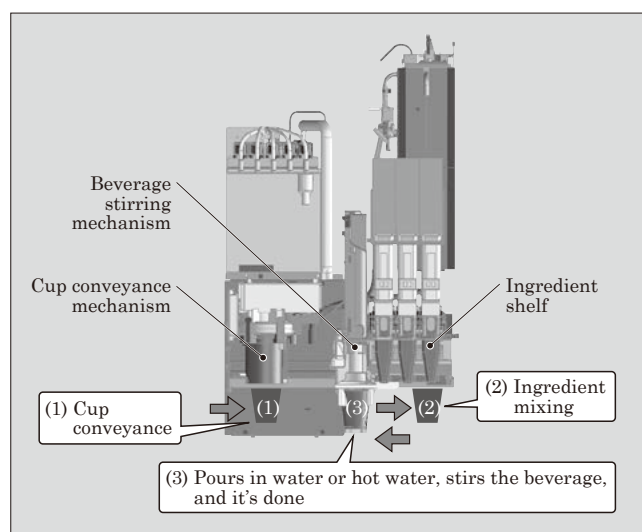


Fig.3 "Thickened Beverage Vending Machine" beverage preparation process

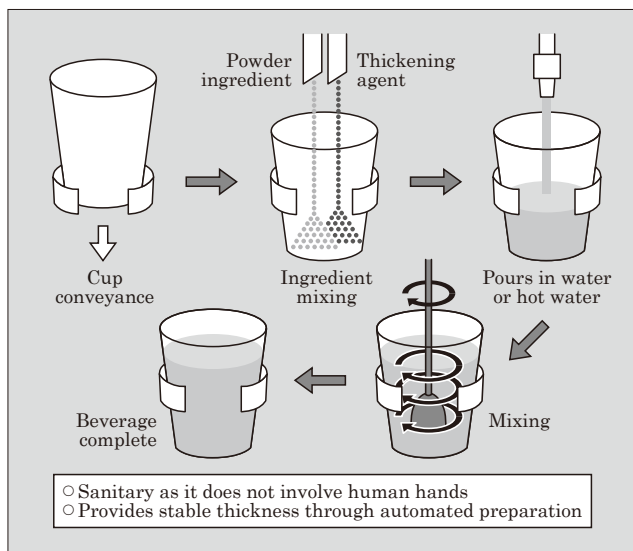


Fig.4 In-cup mixing system

thickened beverage with no residue in approximately 60 seconds. This cuts in half the 120 seconds typically required to prepare thickened beverages by hand (see Fig. 5).

In order to control the temperature of beverages at an optimal level, it uses a system that adjusts the amount of cold water used, instead of relying on ice. Specifically, it utilizes a beverage circuit with a sensor that detects the amount of fluid in automatic tea servers. By precisely controlling the amount of hot and cold water, it stably provides hot beverages at approximately 45°C and cold beverages at approximately 20°C.

### (3) Easy-to-use user interface

The Thickened Beverage Vending Machines utilizes an easy-to-use user interface that is designed based on interviews with medical professionals and caregivers who gave us feedback on their experiences

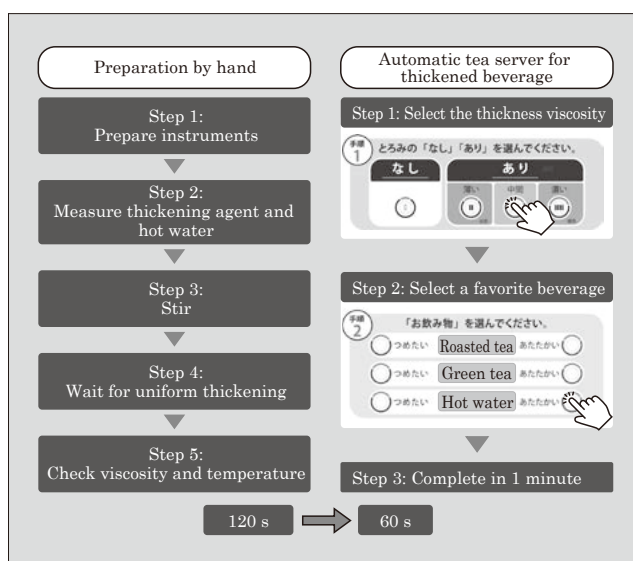


Fig.5 Thickened beverage preparation method

actually using the product (see Fig. 6).

To ensure that no mistakes are made when deciding whether or not to use a thickening agent, it was designed in a way that prevents operation errors and makes it easy to identify buttons at a glance by using a mandatory two-action function, navigation lamp based guide function, and a thickening viscosity display that lights up within a range of LEDs. It also provides the option of selecting non-thickened beverages. This enables it to prepare beverages for both caregivers and care receivers.

#### (4) Automatic cleaning mechanism to maintain sanitary conditions

Since it uses an in-cup mixing system, the only thing that needs to be cleaned after each beverage preparation is the mixing propeller. Moreover, this newly developed Thickened Beverage Vending Machine uses a new propeller system. Figure 7 shows how the propeller is cleaned. This system has structure that has optimized shape of the nozzle that discharges hot water and the height of the propeller to pour hot water over the entire propeller. The timing of pouring the hot water and the rotational speed of the propeller and duration can be changed to accommodate different beverages.

We evaluated the sanitation of this new clean-

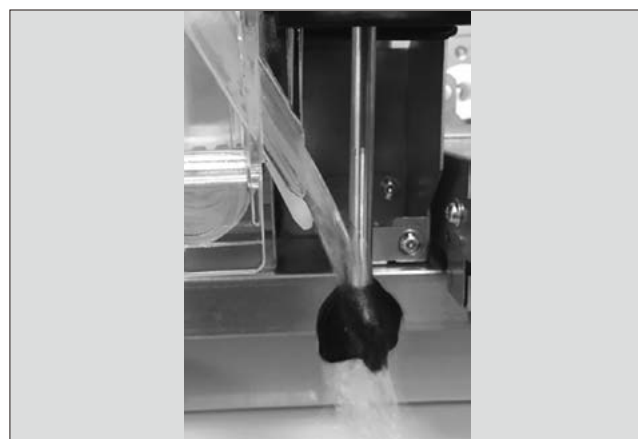


Fig.7 Propeller cleaning

ing method with the aerobic plate count as criterion, which is adopted in the ATP (adenosine triphosphate) test kit used in medical institutions. We set the target value for a sanitary propeller condition to  $10^2$  or less, which is the criterion according to the Water Supply Act. This is stricter than the criteria for food products, an aerobic plate count of  $10^5$  or less, since it will be mainly used in hospitals and nursing homes. We verified that this cleaning method maintained an aerobic plate count of 10 or less, demonstrating that it ensured a sanitary condition.

## 4. Postscript

In this paper, we introduced the “Thickened Beverage Vending Machine” in-cup mixing automatic tea server. As Japan evolves into an aging society, reducing the burden on those engaged in nursing care will continue to be a challenge in the future. We believe that this product will help meet this challenge. Moving forward, we will continue to address social challenges and develop products that contribute to people around the world.

## References

- (1) National Dysphagia Diet Task Force American Dietetic Association. National Dysphagia Diet: Standardization for Optimal Care. American Dietetic Association, Chicago, Ill, 2002.

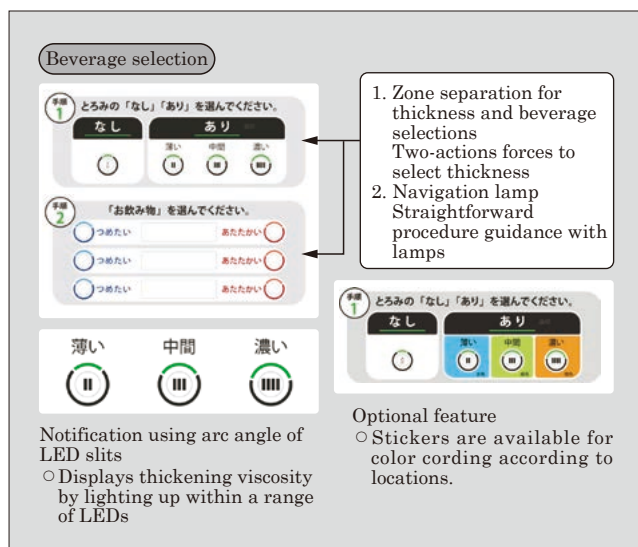


Fig.6 User interface



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