

# Vending technologies in improving food services

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**Abstract.** To date, vending machines are widespread. If abroad vending machines are used everywhere to sell a wide variety of goods and even services, then in our country, so far, as a rule, only classic coffee machines and spring machines for issuing snacks attract the attention of buyers. Only in recent years, there has been a trend towards the emergence of atypical vending machines in Russia, such as vending machines for the sale of french fries, coffee shops, dumplings, pizza makers, etc. The article presents the developed vending machine for the preparation and sale of potato balls, the principle of operation of innovative vending, the recipe for potato balls with fillers.

## 1 Introduction

Vending has become widespread in the world as a convenient and not very demanding way to trade or provide services. Vending has various directions and is used in almost all spheres of society.

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Most experts believe that the pandemic has given a new round in the development of vending technologies in improving food services, since the purchase of drinks and ready meals through a vending machine is a contactless operation. Also, devices that offer quality dishes to the consumer can be distributed at business meetings, holidays, catering services, in conditions where it is impractical to organize a full-fledged kitchen, in conditions of lack of space. The development of vending technologies is evidenced by innovative solutions presented at exhibitions in recent years, including a dumpling machine from a development team from Kazan, Brambor machines for vending potatoes from Czech farmers, a pizza machine from XRobotics, a vending store on wheels "Stop and Shop", offering delivery of a whole kiosk with fresh vegetables and fruits directly to the buyer, all this without contact

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with the consumer. This is evidence that vending technologies are developing, being introduced into everyday life [1-3].

Profit will be brought by the most unusual, attractive, but at the same time trustworthy devices.

Since a relatively long time (one of the first models appeared in 1988), attempts have been made to introduce vending machines-deep fryers. Disadvantages, as well as the high cost of devices did not allow them to become widespread. One of the main drawbacks is the difficulty of working with deep-frying. The product turned out to be too greasy, harmful, and the device also needed frequent maintenance (changing deep-frying, cleaning the cooking surfaces), without proper ventilation it heavily polluted the air. The advent of air frying technology has become a solution to these problems and a chance for vending fryers to spread [4].

Air frying is a technology of cooking in a stream of hot air with a small amount of deep-frying. The key advantages of this technology in comparison with classical deep-frying can be noted: low fat content, minimal loss of nutritional value, the highest quality indicators and organoleptic assessment; no need to change the deep-fryer; ease of maintenance of the device; Simplified ventilation design [5-7].

The above factors make it possible to use this technology for cooking potatoes and many other dishes inside the vending machine. To date, there are machines for frying and selling french fries.

A vending machine with a built-in microwave oven is known for the implementation of complex meals for students [8].

The first vending machines for frying and selling French fries are known. The principle of operation of the device is as follows: from refrigerating chambers with separating partitions, which are serviced by a separate compressor, with the help of dosing devices, the semi-finished product enters the conveyor, which is delivered to the inclined grate. The grill is immersed in a bath of heated oil, where the process of cooking potatoes or other products is carried out. After cooking, with the help of an eccentric mechanism, the grate tilts, thereby removing the finished product from the oil bath. Next, the finished product enters the funnel into disposable tableware prepared in the dispensing connector. The design of the device also has 2 tanks (178, 200) for fresh and used oil, respectively. After every 4 frying cycles, the oil is renewed thanks to a system of pumps and valves.

Advantages: one of the first representatives of machines of this kind, was repeatedly used as a base for the invention of new vending machines, as evidenced by numerous references from other patents, several products in one machine, a good example of everything a vending machine needs for frying in oil. Disadvantages (opportunities for improvement): large, by modern standards, dimensions, a lot of working mechanisms (conveyor, dosers, compressor, eccentric mechanism, oil pumps, valves), which leads to negative consequences in the form of: a drop in the reliability of the system; high energy intensity; material consumption, etc.

The authors carried out comprehensive studies of the needs of consumers of the vending service system in the social sphere of food - students, teachers, employees of the largest economic multidisciplinary university. In the West, especially in Japan, vending systems have become very widespread, this is essentially the "Hi Tech" industry ("Vending in Russia 2021" [2,3]). Taking into account the relevance of the problems of the development of the vending machine industry, the authors of this work have already carried out studies of the quality of vending machines for a number of years (2018-2021); Therefore, this work is a continuation of the study launched in 2018 [6-8].

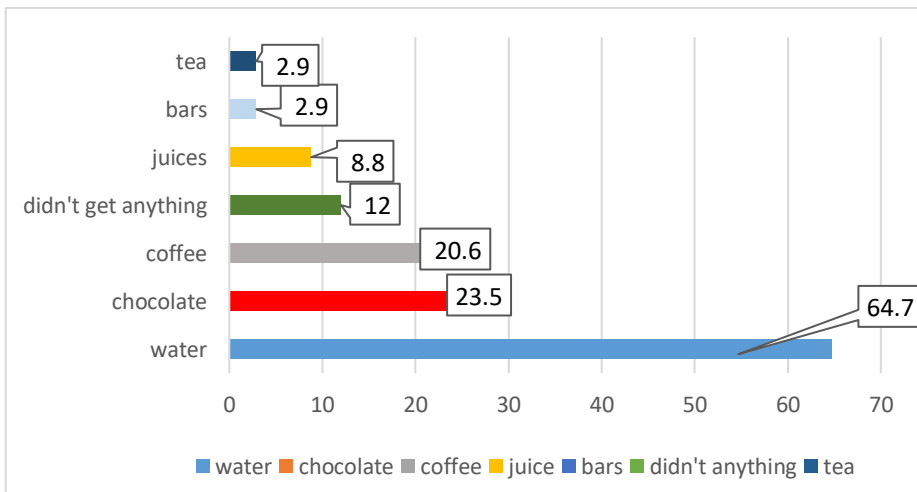
In a study conducted using online questionnaire methods, it was found that consumers (university students, teachers, staff) purchased mainly carbonated and non-carbonated water, chocolate and other confectionery products, coffee / tea and other drinks. The

possibilities of catering in this segment on the basis of the principles of the concept of rational nutrition are revealed. Recommendations were made to improve the assortment, improve the quality of semi-finished products loaded into the devices, and optimize the technology for their rapid preparation (M.A. Belyaeva et. al., 2018).

Using the method of online research, visual inspections, conversations with service specialists, the features of the functioning of vending machines, the positive and negative aspects of the automated sales system for semi-finished products, food, water and beverages were revealed.

An analysis of the assortment of food and culinary products sold through the "network" of vending machines led to the conclusion that consumers purchased mainly carbonated and non-carbonated water, chocolate and other confectionery products, coffee / tea and other drinks. In the future, the demand for advanced functionality of vending machines (copying, scanning, sale of hygiene products, optics, photographing and printing photos from remote access databases, social networks, etc.) is predicted.

When analyzing the results of the online survey, a number of our own experimental data were obtained. In particular, the following product groups were in the greatest demand: bottled water – about 48% of positive responses from respondents, coffee – 15%, tea – 2%, chocolate and other confectionery products – 17%, juices – 7%, bars – 2%. (Fig. 1). At the same time, some respondents (about 9%) did not use vending machines.

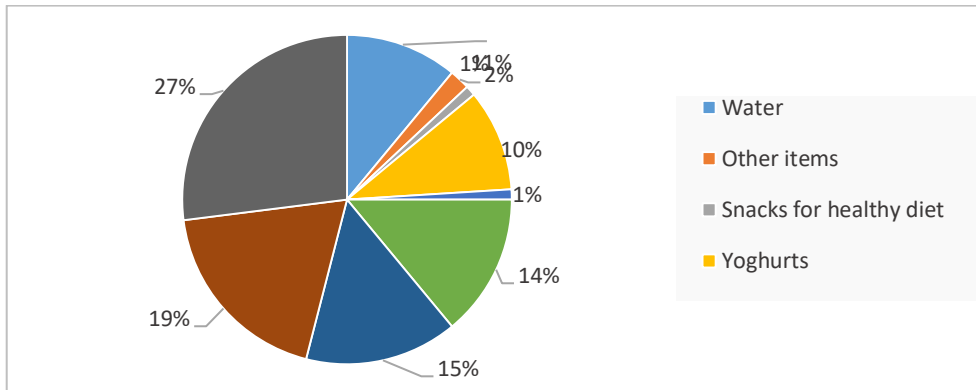


**Fig. 1.** Diagram of the distribution of answers to the question "What products do you most often purchase through vending machines?"

Finding out the peculiarities of the respondents' answers to the question "What kind of food products would you like to see in vending machines?" (Fig. 2) it is necessary to note the predominance of demand for waffles, croissants, sandwiches, tea, coffee; chips, crackers, biscuits, biscuits, snack foods for a balanced diet and water. It can be considered rational to create fast food products that have the properties of functional foods, for example, snacks enriched with vitamins/

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In the context of a very turbulent market situation, geopolitical problems, and the ongoing development of the COVID-19 pandemic, a more rational, scientific, system-standardized (ISO MS) organization of vending services for the socially significant food sector is needed. We take into account the principles of various concepts of nutrition, in particular, healthy eating, functional, sports, etc.



**Fig. 2.** Diagram of the distribution of answers to the question "What non-food products and/or services would you like to see in vending machines?"

It is advisable to provide for automated monitoring of the operation of vending machines, in particular, with the help of photo and video cameras already installed in the premises of the buildings of the object under study, on the sites in which the vending machines are located. The problematic aspects in the work of vending machines for a number of years of our observation are the following (in descending order of importance): the inability to pay by cards; unsuccessful operating time (refueling machines with products); periodic lack of products; frequent malfunctions; non-delivery of change and selective acceptance of banknotes; limited range of products; Recently, a number of devices have been turned off altogether, apparently due to minimal demand in a pandemic.

In accordance with the foregoing, the range of products should be diversified due to new high-quality commodity items that meet the criteria of modern scientific concepts and, apparently, should be monitored and improved by the relevant departments of the constantly improving food system not only of the university, but also the introduction of vending technologies.

It is rational to propose the principles of the management system on the basis of international and national standards ISO 9000, 14000, 22000 [4], which requires the development of a separate scientific project. Since the most purchased types of products are confectionery and flour products in special factory packaging, it is advisable to implement, for example, functional snacks enriched with micronutrients, according to the recommendations of the health authorities. Our own results allow us to formulate recommendations aimed at a phased, comprehensive improvement of the vending service system in the context of a difficult geopolitical situation, the ongoing COVID-19 pandemic and the restructuring of the food system.

The main proposals are aimed at diversifying the range of products sold, new market positions (for example, snacks for healthy eating), searching for new market segments / niches, etc. It is necessary to optimize quality control, especially at the stage of incoming control when purchasing food products and products of an additional (non-food) assortment. Interesting data on new functions of vending, for example, photocopiers or printing photo content, for example, from social networks.

Taking into account the "crisis" or "protective" behavior of the majority of consumers, it is necessary to choose a supplier with the lowest prices for products, to establish a minimum level of margin for automated service in the food system of the university. At the same time, the quality of purchased semi-finished products and products for vending machines remains in the first place.

To quickly resolve the quality issues of incoming and developed products, a laboratory and analytical service is needed for quality control / physicochemical studies of food products. In addition, the principle of individualization of service can be implemented (possibly with the use of artificial intelligence technology, Metrology 4.0 programs, ISO standards, etc.), especially when pre-ordering using mobile communications, computer equipment. However, for this purpose, it is necessary to develop an appropriate software application for smartphones, tablets, computers.

Marketing research has shown that there is to expand the range of vending machines and introduce them in the food industry.

Especially to expand the creation of such vending, in which it is possible to carry out the preparation of culinary products and their sale in a contactless way, where there is no interaction between the seller and the buyer.

Based on marketing research and analysis of the vending machine market, vending machines were developed for a variety of purposes [7,8].

Plekhanov Russian University of Economics has developed vendings for the preparation and sale of culinary products, for the preparation and sale of cinnabons, popcorn, potato balls, drinks for sports food, cocktails. The following is the developed vending machine for the preparation and sale of potato balls [6,7,8].

## **2 Materials and methods**

A complex oil change system causes pauses in the operation of the device (every fifth client will have to wait for an oil change). Low quality of the finished product due to uneven roasting, excessively oily, because the product directly from the oil gets to the consumer, the lack of a well-thought-out ventilation system. Another vending is known, which is an improved version of the device discussed earlier, released relatively recently (2016), an automatic machine for the sale of french fries, during the functioning of the vending, a system for air ventilation using a liquid filter is used, the air duct system is designed to direct the air extracted from the roasting system along the surface of water or other water-based liquid to precipitate fat particles on it, present in the extracted air.

Modern methods of marketing research. Conducting an online survey and analyzing the demand for products sold through vending machines.

## **3 Results and discussion**

The principle of operation of the device is as follows: a semi-finished product, in this case, frozen potatoes, from a refrigerating chamber operating with the help of a separate compressor, is dosed through a feed auger into the working chamber. In this chamber, the semi-finished product falls into a grate immersed in a bath with hot oil, where the frying process takes place. At the end of the process, the grate rises, the finished product enters the funnel and through the chute enters the dishes prepared for the consumer in the dispensing compartment. The system has a ventilation system with a water filter in which oil droplets and heavy particles will be retained. Advantage: improved compared to the previous sample, removed mechanisms that complicate the design, such as a conveyor, a system of oil pumps and valves, a new method of feeding a semi-finished product - a feed auger, a

ventilation system with a water filter, which eliminates unpleasant odors during the operation of the device, a simplified system for moving the semi-finished product and product, disadvantages (opportunities for improvement): the inability to change the oil, which will lead to either frequent maintenance or the presence of carcinogens in the product. Oiliness and poor quality due to uneven roasting of the product. The difficulty of maintaining the gutter, on which hot oil gets in the process of operation after preparing the product. This device is an improved version of the previous device, which is a good example of technical solutions. However, there are shortcomings in it that require improvements and new ideas for a solution. Some solutions are offered by the device proposed in the patent, taken as a prototype, because it is as close as possible to the projected one. The innovative design of the working chamber, in order not to have the shortcomings identified in the models earlier, has a well-thought-out air circulation system with a filter system.

The principle of operation of the apparatus is as follows: from the refrigerating chamber, with the help of a dosing device (the execution of which is not proposed in this prototype patent), the semi-finished product falls on a cylindrical mesh-cylinder in the working chamber.

After that, the lattice, consisting of two halves with the help of a reciprocating mechanism, is assembled together, fixed with the help of grooves. The semi-finished mesh cylinder then begins to rotate in a stream of hot air that is fed through a pipe system. The patent indicates approximate indicators for air temperature, the speed of its movement. It is important to note that, as conceived by the creators, the air duct system ends with filters that prevent burning, oil droplets and small particles of the product from entering the air surrounding the device. After the end of cooking, the product with the help of the already mentioned mechanism, in half of the mesh, returns to its original position, where, by turning the mesh, it enters the dishes prepared for the consumer.

The advantages of this device: the best sample, compared to previous models, the complete absence of oil, which has a positive effect not only on the finished product, but also on the complexity of the system, increased (compared to previous models) reliability of the system, due to the smaller number of mechanisms, the idea of using air frying in the vending machine, a good air filtration system at the outlet. Uniform roasting of the product due to the rotation of the drum.

Disadvantages (opportunities for improvement): the lack of a recommended dosing device, the difficulty of dispensing the finished product, because it is impossible to serve dishes from above, the need to clean the cooking element - the grid, some consumers do not consider air frying a worthy replacement for the traditional one, preferring an oily crust. At the Department of Food Technology and Bioengineering, a vending machine was developed for the preparation and sale of potato balls.

Rationale for choosing a product: potato balls are a good option for vending trade: at the proper temperature, the semi-finished product can be stored for a long time without loss of quality; the preparation process takes a short time; aerofrying technology is suitable for cooking this dish; This dish has several varieties, which allows you to provide the consumer with an assortment of similar products, depending on the filling and method of preparation; is an independent dish that can compete with classic snacks, for example, french fries; A fairly satisfying dish with a pleasant crispy crust that can satisfy hunger without harm to health.

The above aspects allow us to consider potato balls as a suitable, but at the same time extraordinary dish for vending trade.

The developed device involves the use of balls with cheese, mushrooms, chicken, ham and cheese. This choice is made on the basis of the popularity of search queries of Internet users (Table 1).

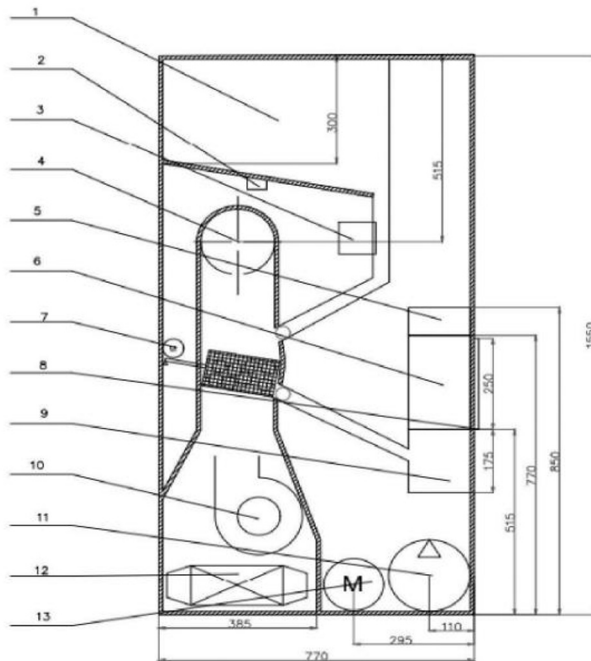
**Table 1.** Popularity of search queries depending on the filling

Query	Number of impressions per month
Potato balls with cheese	3179
Potato balls with mushrooms	124
Potato balls with chicken	51
Potato balls with ham and cheese	44
Potato balls with bacon	32
Potato balls with pork	25
Potato balls with beef	6
Potato balls with turkey	4
Potato balls with vegetables	1

The developed device offers the consumer a small assortment of potato balls with various fillings (3-4 positions) made from frozen semi-finished products. The product will be prepared using the technology of an air fryer, at the request of the consumer with the addition of oil for roasting. Also, the device will offer several sauces to choose from. It will be possible to pay for the order in cash and non-cash, as well as through a special application for mobile (to download the application, a QR code will be provided on the body of the device) (Fig 1).

The device has a small screen with support for several languages, which will greet and guide the client, after choosing an order, to show a short video about the operation of the machine and a set of interesting facts about potato balls, including, of course, facts about the benefits of this dish. At the end of the cooking process, the screen will wish bon appetit. The body of the device will have glass inserts so that the buyer can observe the process of cooking his dish. Also, the consumer will be offered the purchase of branded reusable tableware, which not only helps to preserve the environment, but also gives the buyer a discount on products.

The device will work as follows: after the user has completed the order using the touch menu or through the mobile application and made the payment, the semi-finished product (frozen potato balls with the selected filling), from the refrigerating chamber divided into sections, enters the compartment for receiving and dispensing using a dosing device. With the help of a translational-return mechanism, the semi-finished product moves to the cooking area, where it rotates in a stream of hot air. Hot air is created by means of a heating element, moved through the duct by means of a fan and filtered at the outlet of the apparatus by a filter. If the consumer has chosen the option of cooking in oil, oil is supplied from the reservoir to the nozzle. The oil is sprayed on the product, which gives the crust a pleasant oiliness.



**Fig. 3.** Functional scheme of the vending machine

1 - refrigerating chamber, 2 - dosing device, 3 - compartment for receiving and dispensing, 4 - cooking area, 5 - heating element, 6 - filter, 8 - tank, 7 - nozzle, 9 - dispensing area through a funnel and inclined chute, 10 - touch menu, 11 – compressor, 12 – heater, 13 - electricmotor

After the end of the cooking process, the translational-return mechanism moves to the receiving and dispensing position and unloads the finished product into the dispensing area through a funnel and an inclined chute (it is impossible to use a straight chute, because this will make it difficult to dispense dishes). In the pick-up area, the product falls into pre-prepared dishes. The sauce and a bag of spices selected by the buyer will also be delivered there.

## 4 Conclusions

The working chamber is a compartment in which the product and the hot air flow intersect. It has the shape of a rectangular parallelepiped with a slight bend on one wall. The scheme of operation is as follows: the electric drive raises the working chamber, which is a mesh drum at a small angle, after which the semi-finished product from the hopper enters the working chamber. Then, with the help of a drive, the drum takes a horizontal position and begins to rotate. The minimum gap between the curved wall and the drum does not allow the semi-finished product to fall out of the mesh drum. The fan supplies hot air that passes through the product and exits through the ventilation system. After the cooking process is completed, the drive tilts the drum and the finished product enters the dispensing area.

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