

Research Article

Design and Research on Soybean-milk Machine

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Abstract: The purpose of this research is to design a soybean-milk machine that could make fresh soybean-milk, soup and other drinks automatically through the high-speed rotation of the motor to drive the blade to strongly strike, stir, cut and heat for soybean, rice and other grains, supplemented by stirring of microcomputer control. It specifically researches the shape design, color design and the design of internal structure. The study elaborates that the shape design of soybean-milk machine should follow the art rule of variation and unity and meanwhile the whole shape still should be simple and direct; the color design of soybean-milk machine not only should satisfy the request of man-machine coordination and environment and function, but also should value the choice of tone, match the new age request of appreciation beauty and notice novelty. And then the detailed analysis for the working principle of soybean-milk machine is made, based on which the conclusion has been reached.

Keywords: Color design, shape design, soybean-milk machine, structure design

INTRODUCTION

Soybean-milk originated in China, widely circulated, which is a traditional food of the Chinese nation and also is a nutrition food accepted by modern science. With the improvement of family living conditions and enhancement of living standards and out of respect for food safety, the soybean-milk as a green and healthy drink that is rich in vegetable protein enters into the thousands of large and medium-sized cities with an unstoppable charm (Jiang, 2014a). The equipment of making soybean-milk used in the main process of processing bean products has a long history in our country (Miao, 2013). The earliest soybean-milk was recorded on a piece of the unearthed slabstone, which was made in about 25~220 AD and on which the scene of making soybean-milk in the ancient kitchen is engraved. It is generally considered that the origin of the soybean-milk is a story in more than 2000 years ago that in the Western Han Dynasty the filial son Liuan who is the king of Huainan daily used the soybean soaked in the water to grind into soybean-milk for his mother during his mother's illness and his mother gradually recovered. Accordingly, soybean-milk was introduced to the folk. "Compendium of Materia Medica" records that soybean-milk has the efficacy of exhausting gas, diuresis, dispelling wind and reducing heat and detoxification. "Secret Record of Prolonging Life-span" also records that soybean-milk has the efficacy of growing skin, benefiting complexion, filling bone marrow, adding strength, tonifying deficiency and working up an appetite. It has formed the traditional process of making soybean-milk of choosing soybean,



Fig. 1: Traditional stone mill used to make soybean-milk

soaking soybean and grinding soybean, forming the traditional soybean-milk culture (Kang *et al.*, 2012).

In the 1970s, in Pinglu county of Shanxi Province, the officer commune machinery factory uses of local resources of granite to create the stone mill driven by motor, cleverly combining ancient technology and modern elements (Qi *et al.*, 2012). Figure 1 is the traditional stone mill used to make soybean-milk. Relative to the traditional craft of using stone mill to make soybean-milk, currently there is also a kind of hand-operated soybean-milk machine in the market and the price is low, as shown in Fig. 2.

Drinking soybean-milk has had 2000 years history in our country, but the soybean-milk machine that really has modern significance does not appear until the end of the 20th century (Jiang, 2013). In just more than a decade, the soybean-milk machine has developed from the mesh technology of the first generation to the no mesh technology of the third generation. The soybean-



Fig. 2: Hand-operated soybean-milk machine



Fig. 3: Big mesh soybean-milk machine of the second generation



Fig. 4: No mesh soybean-milk machine of the third generation

milk machine of the first generation and the second generation respectively, configures the mesh enclosure of fine mesh and big mesh in the body, as shown in Fig. 3. Because of having the mesh enclosure, some health dead angles that could not be cleaned exist, residue fermenting, so it causes health problems. And that the mesh enclosure needs to be unscrewed to clean, so it is easy to cause aging of thread at lower cover of handpiece and the mesh enclosure to drop. In February 2008, the first domestic soybean-milk machine came out

and won the national patent for utility model. The soybean-milk machine enters into the age of no mesh, as shown in Fig. 4. It adopts the latest technology of gathering flow, making the tool bit form the largest driving force of gathering flow in the process of rotating. It uses microcomputer to control motor speed so that soybeans get more uniform grinding and nutrients release in full. Therefore, the soybean-milk machine of the new generation is more convenient, practical, economic and healthy which could meet the needs of consumers (Kang *et al.*, 2012).

The purpose of this research is to design a soybean-milk machine that could make fresh soybean-milk, soup and other drinks automatically through the high-speed rotation of the motor to drive the blade to strongly strike, stir, cut and heat for soybean, rice and other grains, supplemented by stirring of microcomputer control. It specifically researches the shape design, color design and the design of internal structure, of which the shape design should follow the art rule of variation and unity and meanwhile the whole shape still should be simple and direct; of which the color design not only should satisfy the request of man-machine coordination and environment and function, but also should value the choice of tone, match the new age request of appreciation beauty and notice novelty.

MATERIALS AND METHODS

Shape design of the soybean-milk machine: In the shape design of the soybean-milk machine, above all, the inside quality and the hominization of using of soybean-milk machine must be ensured. Never only pursue the scale and patten beauty of shape design, so as to reduce the quality and other technique function index. The various components of the soybean-milk machine are made up of some geometry bodies which are composed of dot, line and face. The shape design of the soybean-milk machine is combining the material techniques such as structure and function and art contents together, forming a 3D space stereoscopic shape, which has to correspond to art rule, masterly makes use of shape composing principle and masters shape appearance characteristic and forming psychology and vision error of related shape, that is important means to acquire the soybean-milk machine of generous beauty and novel style (Qiu, 2005). The shape design of the soybean-milk machine should be scale coordination, balanced steady and take "unity" as king, "variation" as assist and the line type has to be simple and generous, giving person with comfort, coordination and felling of dynamic in quiet.

Unity: The unity means that among each component of the soybean-milk machine, it has same, similar, logical and harmony nature in the shape, line type, color, part,



Fig. 5: The shape design of unity



Fig. 6: The shape design of concision

carriage, quality, amount and other aspects. But the variation refers to the difference and the contrast of above-mentioned various aspects. The perfect shape has to emphasize unity. But in order to making the image of the soybean-milk machine different, vivid and attractive, it could add the variety in the same nature of unity, harmony and integrity to strengthen each other contrast, but the variation has to be appropriate, not excessive to avoid huge miscellaneous, chaos and centrifuge, as shown in Fig. 5.

Concision: The whole shape design of the soybean-milk machine should be as far as possible simple and direct to acquire a whole, simple and direct style, which could adopt following two kinds of methods. The first, the body design of the soybean-milk machine should apply some basic geometry body or some more simple curves and curved face, of which the shape is rule, simple and explicit, giving person with the deep impression and it is easy to achieve the art effect of simplicity, direct and clear, enrich and abstract, as shown in Fig. 6. Meanwhile, the manufacturing craft of rule shape is simple and easy to have extensive, high quality and low costly production. The second, adopting the shape design of close type, which not only reduces dust

invading, but also covers up main body of the soybean-milk machine, makes its whole good and attains a simple, direct and clear visual effect (Jiang, 2014b).

Color design of the soybean-milk machine: The color design is an important constituent part of the design of the soybean-milk machine, as color has more ocular, more strong and more attractive magic power than the body. The color could firstly influence the person's sense organs than the body, moreover, that could raise user recognizing and watching degree to some operation controls, show instrument and appearance by making use of vision recognizing effect and psychology of color, sequentially, the function of these device could be well developed and the mental request of user could be satisfied. The color design of the soybean-milk machine should follow the following few important points.

Satisfy the request of man-machine coordination: The color design of the soybean-milk machine should well embody the relation of man-machine coordination, so as to make user's mood pleasant, don't easily produce confusion and then attain to the purpose of operating accurately. For example, generally, the base and body of soybean-milk machine properly adopt heavy and solid deep color, not only bearing dirty but also making person have the dependable sense of stability to machine. The other parts are the components that person usually use, which properly adopt bright color, so as to get rid of depressed feeling, satisfying the request of operating accurately and man-machine coordination.

Satisfy the request of environment and function: The color should well express the function characteristic of product and mutually coordinate with the use environment. If the greasy dirt of use environment is serious, usually the dark color is proper for bearing greasy dirt. The color of the panel of soybean-milk machine generally properly use the neutral base color of low bright degree and low pure degree, contrasting with component color, so as to enhance the vision recognizing degree. The panel should have no strong reflection and dazzle light. The color of display part should be obvious and refreshing, but not dazzle eye. The color of caution part should be fresh and gorgeous to come into notice and the color of concealment part should be quiet, as shown in Fig. 7.

Value the choice of tone: The choice of main tone of soybean-milk machine is a problem of very importance, the different tone will form different art effect. In matching color of soybean-milk machine, having main tone can seem to be to unify. The color is more little, the main body characteristic is more strong, the decorate characteristic is more good and the external form relation of soybean-milk machine is more unify.



Fig. 7: The color design of soybean-milk machine satisfying the request of environment and function

Contrary, the color matches more much, causing the color more disorderly, so that it is difficult to adjust generally, the main body characteristic is unclear and the harmonious effect is broken.

The choice of tone still needs to notice whether unique beauty. It needs to hold tight people's mental request for the color of soybean-milk machine, transform the tone of soybean-milk machine to make it produce an unusual attraction, in the meantime, increase the category of tone to satisfy people's fondness for different colors.

Moreover, the base, the body and other big pieces of soybean-milk machine are suitable to use a low pure degree color as the main body color and use clear, elegant and clean color to unify overall situation to make the main tone definite. Using little area of high purity color to embellish to make the



Fig. 8: The color design of soybean-milk machine matching the new age request of appreciation beauty

whole seem to be abundant, change and organic. The whole color generally uses monochrome or two sets of colors, not more than three sets of colors (Fu, 2002).

Match the new age request of appreciation beauty:

With the progress of the age, the improvement of people's living standard and the increase of cultural art accomplishment, the appreciating beauty standards also change. In a certain period or a certain region or world scope, some colors are popular with people and are extensively popular, becoming the "popular color". The "popular color" has a strong age characteristic, as a result, in a period, it become the color which is used extensively. The color design of soybean-milk machine also should sufficiently consider using the "popular color" to accord with the age request, as shown in Fig. 8.



Fig. 9: Structure chart of soybean-milk machine

Notice novelty: The color design of soybean-milk machine should notice novelty and creativity to make it have vitality and more competitiveness. The color of soybean-milk machine not only can satisfy the request for appreciating beauty, under the particular condition, but also has strong influence, which can cause the transfer of people's emotion and interest to attract people's attention. For example, on an international industrial product exhibition, a blue soybean-milk machine produced by some country appeared in the exhibition hall. Though the blue is not the color that the soybean-milk machine consistently uses, the factory surprisingly adopted blue color to decorate the soybean-milk machine, causing the purchaser to crowd in its vicinity and then understood its function characteristics, which produced a surprising sensation effect and made its order enormously exceeded other nation. It is thus clear that the novelty of color design is very important.

Structure design of the soybean-milk machine: Soybean-milk machine is mainly composed of cup body, handpiece, heater, blade, spill-proof electrode, temperature sensors and dry-proof electrode, as shown in Fig. 9.

Cup body: Cup body should have handle and outlet, which is mainly used for filling water or soybean-milk, which could be designed into large cup shape and which could be made with plastic, stainless steel or polycarbonate. But when designing, it is advisable to choose stainless steel, because it is easy to clean. Cup body should be marked with the "up water level" and "down water level" line so as to regulate the water amount added in the cup body. The up mouth of cup body should just entangle the lower cover of handpiece so as to play a part in fixing and supporting the handpiece.

Handpiece: Handpiece is the assembly of soybean-milk machine. In addition to the cup body, the rest of the parts should be all fixed on the handpiece. The shell of the handpiece could be divided into the head cover and the lower cover. The head cover should be equipped with the handle, the working indicator light and the power socket; the lower cover could be used to install the main parts, of which the upper part, namely the inside of the handpiece, could be installed with computer board, transformer and motor, of which the lower part should be equipped with heater, blade, mesh enclosure, spill-proof electrode, temperature sensors and dry-proof electrode.

Heater: The heating power of the heater should be 800 w. The heater adopts stainless steel, used for heating soybean-milk. The bottom half of heating tube should be designed to be a small semicircle so as to be easy to clean.

Blade: Blade is used for smashing soybean, so it should be designed to be the shape like propeller and adopt stainless steel of high hardness.

Spill-proof electrode: Spill-proof electrode is used for detecting the boiling degree of soybean-milk, preventing the soybean-milk from spilling. It should be located at the upper part of the cup body. Spill-proof electrode must be cleaned in time to guarantee normal work. Meanwhile soybean-milk should not be too thin. Otherwise, spill-proof electrode will lose protective effect, giving rise to spill.

Temperature sensor: Temperature sensor is used for detecting water temperature in the cup body when preheating. When the water temperature reaches the setting temperature (usually required about 80°C), it starts motor to work.

Dry-proof electrode: This electrode could not be taken as independent component to use, but should be located in the stainless steel shell of the temperature sensor. Dry-proof electrode should be able to be inserted at the bottom of the cup body, so the length is longer than the spill-proof electrode. When the water level in cup body is normal, the lower end of dry-proof electrode should be soaked in water. When the water level in cup body is low or there is no water in the cup body, or the handpiece is lifted and the lower end of dry-proof electrode is made to leave the water surface, MCU detects this state through the dry-proof electrode and then to ensure safety it will stop the soybean-milk machine working.

RESULTS AND DISCUSSION

Soybean-milk machine is composed of blender of smashing soybean, heater of heating soybean-milk and control circuit. Firstly, it uses the motor to drive the blade to smash soybean into powder; Then heating water, it is usually that after the water temperature heated to 80°C it begins to beat and boil pulp; Finally, after a period of heating and boiling, it becomes soybean-milk. Currently in the market the full-automatic soybean-milk machine controlled by MCU, of which the control system principle diagram is shown in Fig. 10, so long as pressing the start button, begins to work and for a while the both nutritious and delicious soybean-milk just could be drunk. It is usually that the full automatic process of soybean-milk machine such as preheating, beating pulp and boiling pulp, is all controlled by MCU, again through the relay unit made up of multiple relays implementing circuit switching to complete, at the same time, the operation of the motor is also controlled by MCU. The three sensors in soybean-milk machine are respectively used for measuring water level, spilling and temperature. The key of soybean-milk machine is used for controlling the working condition. When working,

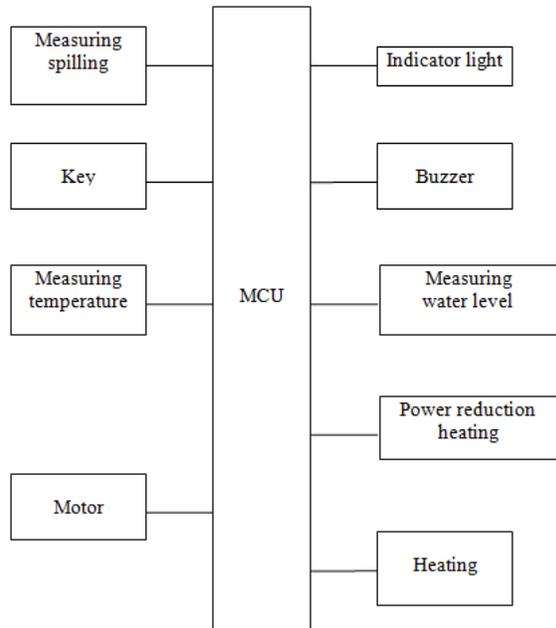


Fig. 10: Control system principle diagram of the full-automatic soybean-milk machine

there are two kinds of heating methods, which, respectively are heating and power reduction heating. At the same time, the buzzer is used for alarm and the indicator light is used for prompting alarm (Kang *et al.*, 2012).

The basic functions possessed by the soybean-milk machine in current market have separate heating, separate smashing, automatic working, no water alarm, power reduction heating, automatic detection, etc. The function of separate heating could heat separately and could stop heating at any time. The function of separate smashing could smash separately. Automatic working refers to the situation that when having water, the electric heating tube begins to heat and when the water temperature goes up to 82°C, stopping heating, motor starts to work and then continuing to heat. When the bubbles produced by soybean-milk machine encounter the spill-proof electrode, it turns into power reduction heating, heating for a few minutes again, finishing and giving an alarm. The whole process is in the condition of no water alarm. Stopping working status refers that during the course of separate heating, separate smashing and automatic working, whenever lifting it up, the soybean-milk machine will stop working and give an alarm. When putting it down again, the soybean-milk machine will return working condition. Automatic detection refers that the soybean-milk machine has the functions of automatically detecting water level, spilling and temperature (Kang *et al.*, 2012).

Currently the making pulp principle of soybean-milk machine has mesh enclosure type and no mesh type. The mesh enclosure of soybean-milk machine of mesh enclosure type is used for filling soybean and

filtering soybean-milk. When working practically, the motor drives the blade to rotate, forming vortex and the blade cuts beans in the vortex, producing collision with cup body wall, forming backflow, such circulating. In general, it exactly is rotating, vortex, cutting, collision, backflow and circulating. The making pulp principle of no mesh type exactly is rotating, vortex, turning, rebounding, cutting and circulating. Whether it is mesh enclosure type or no mesh type, the work steps of soybean-milk machine are the same: preheating, beating pulp, boiling pulp and cooking.

CONCLUSION

- The soybean-milk machine is easy to install, repair and replace spare parts. The design is in accordance with principles of ergonomics and it is convenient to operate and safe and reliable to use.
- The overall structure of the soybean-milk machine is concise and reasonable.
- The manufacturing technical requirement and manufacturing cost of the soybean-milk machine is low and the standard parts are plenty, so general machinery factories could make by themselves.
- Having the function of automatically controlling the concentration of soybean-milk and others.

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