

Development of Mobile Application for Ice Cream Mix Calculation

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Abstract—This research developed a mobile application compatible on Android Operating system to calculate the ice cream ingredients based on Serum Point method. Process of making ice cream requires very specific ingredients, everything must be precise, and nothing can be more or less. Ice cream maker just slightly miscalculates some ingredients, it may cause the ice cream taste and quality. There are a few ways for ice cream maker to make this calculation very accurately. Most sources available on the internet and some of them available off-line. One of them is website with web-based application for calculating ice cream ingredients. Besides website, the other one is Visual Basic for Excel programming (VBA). This VBA has been implemented to create an Excel spreadsheet with capability of calculating ice cream ingredients as well. However, website and spreadsheet are not compatible with mobile devices e.g. smartphone and cellphone. It has been several years that number of mobile user has been rising exponentially more and more and home ice cream maker or small scale business tend to prefer using smartphone to calculate ice cream ingredients more than computer laptop and desktop. This mobile application turns desirable components of ice cream maker into algebraic formula and provides a correct result, based on required compositions including milk fat, milk solids-not-fat (MSNF), sweeteners, stabilizers, emulsifiers, and egg yolk. This application applied linear equations based on Serum Point method which is widely accepted and applied in calculation for ice cream mixes. The results of this work produced various satisfied features i.e. correct percentage of ice cream ingredients. It is more versatile and more user friendly to mobile devices than its predecessors, Excel spread sheet and web-based application.

Index Terms—android application, ice cream, ice cream mix calculation, mobile application, serum point method

I. INTRODUCTION

Ice cream is a frozen dessert made of milk fat, milk solids-not-fat (MSNF), sweeteners, stabilizers, emulsifiers, and flavors. Milk fat in ice cream increases richness of flavor, produces a smooth texture, lubricates and insulates the mouth [1]. Furthermore, milk fat of mix also aids producing desirable melting properties [2]. The sources of milk fat consist of milk, cream, butter/butter

oil, and condensed milk [3]. The MSNF or serum solids enhance the texture of ice cream, help in giving body, chewing resistance, and high overrun in finished product [4]. The MSNF in milk and milk products comprise lactose, caseins, whey proteins, minerals, vitamins, acids, enzymes, and gases [2]. Fresh concentrated skimmed milk or spray dried skim milk powder are the traditional sources of MSNF. Milk fat and MSNF contents in ice cream vary in different country, depending upon regulations. In Thailand, milk ice cream is prescribed to have milk fat and MSNF contents that are not lower than 5% and 7.5% by weight, respectively [5].

Sweeteners in ice cream give the body and texture, improve flavor, sweetness and viscosity. The most common sweetening agent used is sucrose [2]. Stabilizers are used for improvement of smoothness in body and texture, reduction ice and lactose crystal growth during storage, and prevention ice cream melting [1]. Emulsifiers are used to improve whipping quality, produce drier ice cream, give smooth texture, and good melting quality of ice cream. Egg yolk was formerly used as an ice cream emulsifier, which can improve whipping ability and apprise custard flavor.

Formulations of ice cream mix are defined as percentage of the constituent of fat, MSNF, sugar, stabilizer, and emulsifier [1]. Ice cream mixes are made to specification of milk fat, MSNF, and total solids contents. Therefore, once individual ingredient composition is known, formulations will be calculated to balance the MSNF, milk fat, and total solid in the mix [6].

The ice cream mixes calculation is to turn the formula, which is based on the required components, into a recipe, the actual ingredients to be used to supply the components and the amount of mix desired. The formula is given as percentage of fat, MSNF, sugar, stabilizer, and emulsifier [2]. All ingredients should be calculated to ensure that the preparation of final product complies with quality, legal requirements, consumer preferences, availability of raw materials, and cost.

II. LITERATURE REVIEW

Identification the components of each ingredient is the first step of mix calculation. If the component has only

one source of the component, for example stabilizer, emulsifiers, or sugar, calculation can be done directly by multiplying the needed percentage by the needed weight. If the components have two or more sources, for example milk fat is from milk and cream, it is needed to use algebraic method [7].

The manual calculation of ice cream mix known as the Serum Point method. This method assumes constant MSNF (9%) in the serum nonfat portion of all dairy ingredients. Therefore, the MSNF content of milk and cream is calculated as $(100 - \% \text{ fat}) \times 0.09$ [1]. Serum Point Method is applicable for 2 or 3 sources of MSNF i.e. cream, skim milk powder, and milk. This method fits for 3 ingredients. However, it is not suitable for 4 or more ingredients supplying MSNF e.g. milk, cream, skim milk powder, and whey powder [8].

Computer programs were developed for mix calculations to solve equations. Microsoft Excel is a general mathematical software used to solve the algebraic equations for calculate the mix formulations in small manufactures [1]. For example of the Excel spreadsheet for ice cream mix calculation is created by [9]. This spreadsheet can calculate common used ingredients include cream, milk, skim milk powder, stabilizer, emulsifier, sugar, and egg yolk. However, this spreadsheet cannot calculate water, butter, whey powder or concentrated milk as well as some sugars e.g. sugar syrup, dextrose, honey, corn syrup solids, and maltodextrins. Dairy Science and Food Technology developed the seven spreadsheets for calculating ice cream mix recipes [10]. The spreadsheets have been configured to work with many ingredients e.g. cream, whole milk, skim milk powder, condensed milk, butter, vegetable fat, stabilizer, emulsifier, water, egg yolk, sugar (sucrose, dextrose, glucose powders or syrups), and flavoring etc.

In large industrial situations, there are computer software programs for calculation of ice cream mix formulations. This calculation can save time, make optimal use of ingredients, maintain quality of finish product, and provide the benefits on a least-cost [1]. TechWizard™ is a software for mix calculations for ice cream makers. This program can create ice cream recipe with multiple ingredients. Moreover, this program can determine overrun, total amount, cost, nutrition facts label, and generate freezing curve of ice cream [11].

Development of web application of ice cream mix derived from Excel spreadsheets to help ice cream maker easily to calculate the formulations. The ice cream mix calculator in web application is developed by [12] from 11 Excel spreadsheets that covers many formulation of ice cream, using various ingredients. This application can calculate more than 20 ingredients that are suitable for commercial manufacturers.

There are 2 latest technologies of Android application development are available in the software market, hybrid framework and native application. For hybrid framework tools e.g. Xamarin, Ionic, and Angular JS, these tools are capable of creating a mobile application that can be executable cross platform both world major mobile

operating system: Android and iOS. However, application performance in term of speed and hard ware utilization are poorer when compared to the native framework tool. On the other hand, development of mobile application by a native application tool requires advanced skills in computer programing, graphic designing, and higher budget but application performance really satisfies users [13].

III. METHODOLOGY

A. Calculation of Ice Cream Mixes

The amount of skim milk powder was calculated by using the Serum Point method. The amount of needed Skim Milk Powder (SMP) is found by the following equation;

$$SMP = \frac{MSNF \text{ needed} - (\text{serum of mix} \times 0.09)}{\%MSNF \text{ in powder} - 9} \times 100 \quad (1)$$

The serum of mix was calculated by the desired percentage of all ingredients (e.g., fat (F), sugar (S), stabilizer (ST), emulsifier (EM), and egg yolk (EY)) subtracting from 100 following equation;

$$\text{Serum of mix} = 100 - (F + S + ST + EM + EY) \quad (2)$$

The amount of needed milk was calculated by the following equation;

$$\text{Cream} = \frac{\%F \text{ needed} - [C \text{ and } M \text{ needed} \times (\%F \text{ in milk}/100)]}{\%F \text{ in cream} - \%F \text{ in milk}} \times 100 \quad (3)$$

where: %F is the percentage of fat, C is the weight of milk and M is the weight of cream.

The amount of needed cream (C) and milk (M) was found by the weight of sugar, stabilizer, emulsifier, egg yolk, and skim milk powder subtracting from 100 as following equation;

$$C \text{ and } M \text{ needed} = 100 - (S + ST + EM + EY + SMP) \quad (4)$$

The amount of needed milk was calculated by the weight of sugar, stabilizer, emulsifier, egg yolk, skim milk powder, and cream subtracting from 100 as following equation.

$$\text{Milk} = 100 - (S + ST + EM + EY + SMP + C) \quad (5)$$

B. Android Application Development

This application was developed by a native mobile application development tool, Android Studio 3.2 which is the latest version released on August, 2018. All formulas of Serum Point Method were transformed to program variables and algebraic equations in Java language formats. Input method of this application is reliable on textbox, spinner and on-screen keyboard. User interfaces of this application were designed by graphics and icons to make ease of use. It was focused on user friendly approach more than web-based and Excel spreadsheet version. Users of this application must input desirable components via application forms and the program will calculate a final result based on linear

equations of Serum Point Method. Finally, this application was compiled and built to an APK file, installation file for testing and installing on Android devices, compatible with Android OS. Version 5.0.0 to 8.0.1.

IV. RESULTS AND DISCUSSIONS

Mobile application developed from this work is more versatile and user friendly than web-based and spread sheet version. All web-based versions are not responsive design and display to user view. They are not mobile user oriented. When users open a formula page to calculate ice cream ingredient, screen display of web-based form is too large for mobile devices due to screen size constraint. Users have to scroll its view left and right gestures or zoom in and out many times while calculating. Spread sheet version is an off-line application run solely on Microsoft Excel. Users must install Microsoft Excel prior using it. Otherwise, it cannot be executable and run. This kind of spread sheet is not available on internet except for download.

Unlike its predecessor i.e. web-based and spread sheet, this mobile application is more convenient for user to carry handheld smartphone while making ice cream. This application instantly calculates ice cream ingredients by applying a formula of Serum Point method. Icons of this application are illustrated by ice cream pictures. The main menu of this application and a button for users to start calculating ice cream ingredients as shown in Fig. 1. There is a main button for users to tap and redirect to a next layout of ice cream calculation.



Figure 1. Main menu of application

Users have to define how many percentages of each composition they desire to let this application calculate the correct amount of ingredients of ice cream. There are 6 compositions that users have to specify according to the Serum Point Method. For each composition name, it is shown in Fig. 2. Each composition has its own input box, numeric format for users to define. Users have to fill out how many percentages for each component they want in ice cream and all input values will be used in the

formula to calculate ice cream ingredients in the next following steps.



Figure 2. Input forms for ice cream mix composition

When users touch or tap on each input box. Each composition will display an on-screen keyboard, prompt for users to fill out how many percentages of each composition in ice cream they desire, as shown in Fig. 3. Since each box requires number of percentage. Then this application will display only numeric keypads to user. Once, users finish defining each composition percentage, on-screen keyboard will collapse and calculate button will be revealed for user to proceed a next step of calculating ice cream ingredients (Fig. 4).

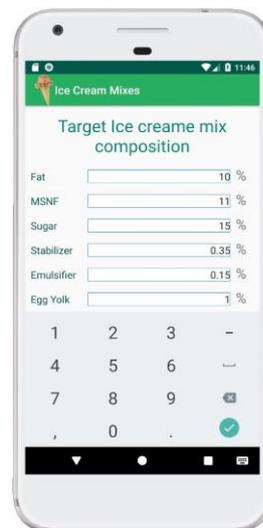


Figure 3. Example of input method of ice cream mix compositions

Due to all input types of composition are percentages, on-screen keyboard will provide only numeric keypad to prevent unwanted value or errors as shown in Fig. 3. In case of users accidentally pass text or alphabetic or symbol values to the application. Thus, with the numeric key pad, users are unable to input wrong data types. This application also provides 2 numbers of decimal point for more accuracy of application performance. The result of calculation also shows the same decimal point numbers.



Figure 4. Example of ice cream mix compositions

Users have to specify a source of fat and its percentage in ice cream to replace these values into the equation. Each source of fat is listed in a list box format or spinner. Once, users touch each a list box, this application will create a drop down list of fat source for users to select. Then, users have to specify how many percentages of each source into to each input box before passing all variable values to the final step. (Fig. 5)



Figure 5. Percentage of fat in ingredients



Figure 6. Result of ice cream mix

After all compositions and sources of fat are defined. This application will bring all values of variables plugged in to the Serum Point Method formula to find out how many percentages of each ingredient required and show the result of all ingredients. Users will be notified by a table view of ingredient as shown in Fig. 6.

V. CONCLUSION

This work created a mobile application on Android Operating system. It is more versatile and mobile user friendly than its predecessors e.g. spread sheet and web-based application. Spread sheet is an off-line application run solely on Microsoft Excel and web-based application is not mobile user friendly. This application solves all mentioned constraints but exhibits the same performance of result. This application applied algebraic formulas based on Serum Point method which is world-wide known and recognized. Users are capable of calculating ice cream ingredient by defining how many percentages of each component. Then, ingredients will be calculated and displayed in percentage format on screen. This application can serve millions Android users who are home ice cream makers or small business ice cream operators who are looking for a solution to calculate their ice cream ingredients on Android devices. For further development, this application database will be implemented online through cloud server. Thus, users will be provided with more update information, more miscellaneous sections and more variety of calculation methods.

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