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Formulation of effervescent tablet detergent compact with unique chemical compositions†

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Abstract: The tablet form of the detergent powder is one of the new delivery systems of the detergent. It is a compact form of detergent powder with highly active ingredients. The tabulated form of detergent reduces the volume of the powder. Due to compact format, it affects the transportation and packing cost. Thus, we aimed to formulate the unique detergent powder with the chemical combinations of various surface-active agents. The detergent formulation thus contains linear alkyl Benzene Sulphonate (LABSA), alfa sulfo methyl esters, Sodium Tripolyphophate (STPP), Sodium hydroxide (NaOH), Sodium Silicate, and Sodium Sulphate, etc. In our study, the detergent powder is mixed with various disintegrating agents like Corn Starch, Sodium carboxymethyl cellulose (Sodium CMC), Silicic Acid, Sodium Carbonate and Citric Acid. Our compact detergent powder showed better detergency properties. This helps to instantly disintegrate and disperse when contacted with water. Detergent powder composition in our currently formulated tablets caused effervescences and disintegrates within 30 seconds at room temperature in water. The tablet detergent has shown better performance than market detergents.

Keywords: detergent powder; disintegrating agents; tablet; delivery system

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1. Introduction

The cleaning products consists of ingredients or materials which when treated with water helps to remove of dirt or foreign matter from the surface [1]. The key ingredients in detergent powder are surfactants and builders as they perform the main role in washing processes, and they directly impact on detergency performance [2]. The tablet form of the detergent powder is one of the novel formats of detergents having a compact form with the highly active ingredients. One or two tablets are enough for the washing instead of one scoop of detergent powder. The life of the tablet detergent is however, in the hands of the ultimate user that the properties of the product do not deteriorate significantly before use. Herein, we demonstrate the formulation of a unique composition-based tablet detergent compact for detergency applications.

2. Materials and Methods

Linear Alkyl Benzene Sulphonic Acid (LABSA) was obtained from M/s Godrej Industries Pvt. Ltd. Mumbai as a gift Sample. Sodium Tri Polyphosphate (STPP), sodium sulphate, sodium silicate, carbon black, and lauric acid were procured from M/s Hi Media

Laboratory Pvt. Ltd. Mumbai. Caustic soda and Starch were procured from M/s Finar India Pvt. Ltd. Mumbai. Disintegrating Agents Silicic Acid, Sodium Bicarbonate and Citric Acid were obtained from M/s Loba Chemical Pvt. Ltd. Mumbai. Ready for Dying cotton (RFD) was obtained from Textile Department, Institute of Chemical Technology, Mumbai, India. Coconut oil was procured from the local market of Mumbai, India.

2.1 Formulation of detergent tablets

The detergent tablet manufacturing process consists of i) neutralization of LABSA ii) Formulation of detergent and iii) compressing to tablet along with disintegrating agents. [Fig.1]

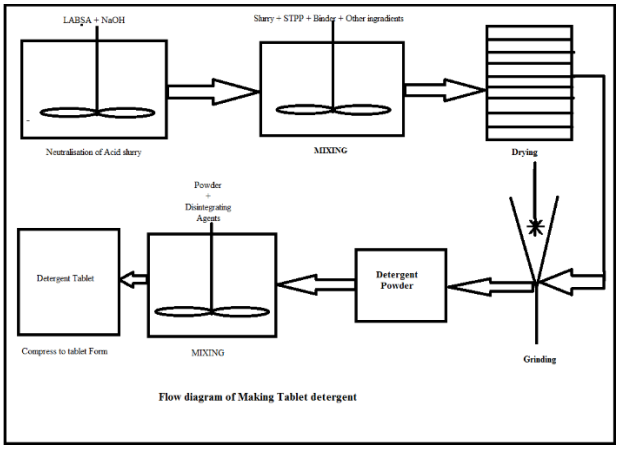

Fig. 1 Flow diagram of making tablet detergent compact

i) Neutralization of Acid Slurry of LABSA

LABSA has an acid value of 225 $\frac{mg\ of\ KOH}{gm\ sample}$,which was neutralized by NaOH solution. As per stoichiometry, LABSA (100 gm) was neutralized with 16 gm NaOH [Table1]

ii) Formulation of detergent

Neutralized LABSA was then mixed with sodium silicate, sodium Sulphate, water and STPP at 55ºC using an overhead stirrer. The quantity of sodium silicate and STPP were depended upon active matter and hardness of water [3-6]. This mixture of Surfactant, binder and other ingredients were dried using a vacuum oven at 70ºC under a pressure of 350mm for 4 to 5 hrs. The dried mixture was converted in fine powder form with the help of a mixer or grinder or ball mill.

iii) Compressing to Tablet form

The fine powder was then mixed with various disintegrating agents like starch, silicic acid, citric acid, and sodium bicarbonate. This mixture of detergent powder and disintegrating agents were compressed with the help of the tablet machine for converting detergents in tabulated form. When this tablet was contacted with enough water the CO_2 was released from disintegrating agents, which facilitated dispersion of the tablet in water.

2.2. Detergency test

2.2.1 Fabric Soiling

The mixture of carbon black, mineral oil and lauric acid (28.4:17.9:17.9 w/w) was mixed with 35.8 gm coconut oil to form a slurry. This slurry was further mixed with 500 ml carbon tetrachloride. The cotton fabric (100 % RFD cotton) having a size 10×10 cm was soaked in the soiling medium for 15 to 20 min. These soiled fabrics were dried at 80°C in the oven for 3 hrs.

2.2.2 Washing

The soiled fabric was washed using Terg – O – Tometer (M/s Wadegati Pvt. Ltd., Mumbai). The soiled fabric was further finally washed with a detergent solution of 1000 mL at 100 rpm and 50ºC for 20 mins followed by a rinsing time of 10 min. The process was repeated for various concentrations of detergents (0.1, 0.25 and 0.5%) in tap water. After washing, the detergency (%) was calculated using Lambert and Sanders formula using reflectance of washed fabric (Rw), soiled fabric before washing (Rs) and unsoiled fabric (Ro) [7].

3.0 Results and Discussion

3.1 Disintegration time

Effervescences of gases (mostly CO_2 and O_2) were released immediately after contacting with enough water. It helped to penetrate water in the compact form of detergent and to disintegrate the tablet in water. The disintegration of the tablet was dependent upon the % of the binder (Starch) and gas removing material (citric acid and silicic acid) used. Minimum 15% starch was required along with 20% citric acid and sodium bicarbonate or silicic acid to disintegrate the detergent from the tablet [Table 2].

3.2 Cleaning performance of detergents and their tablets

Cleansing properties of detergent and its tablet with marketed detergent were studied by % detergency test. The effect of disintegrating agents was also studied at various concentrations (0.1%, 0.5% and 1%) and room temperature using distilled water. The cotton used for detergency was 100 % RFD cotton white colour fabric. It was observed that the detergency of tablet having disintegrating time 0.5 min. gave better stain removal than marketed powder and other detergent tablets [Table 3] [Fig. 2].

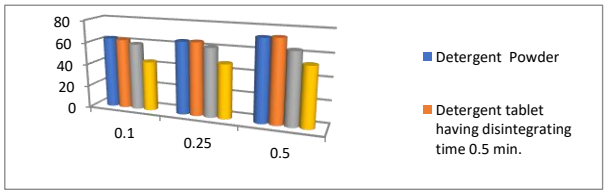

Fig. 2. Graph of % detergency vs. Concentrations

3.3 Foam stability and height

Foaming stability and height are important aesthetic properties of detergent. Foam is nothing but trapping of gas in the liquid. The foaming height and stability were observed in Ross & mill apparatus having volume 3 liters. The detergent and its tablet foam were constant at all concentration also noticed the foam height and stability was same as that of the market detergent sample [Table 4].

3.4 Wetting ability

The wetting properties of detergent and its tablet was observed using 100 % RFD cotton disk having size 0.5 cm radius, which was dipped in detergent solution of various concentration and at ambient temperature. The wetting property of detergent depended upon the concentration of detergent. The detergent tablet had good wetting properties due to the effervescent gases (CO_2 & O_2) from disintegrating agent's citric acid, silicic acid, and sodium bicarbonate. The wetting time of detergent in 1.5 % solution was 38 seconds while their tablet has a wetting time of 32 seconds [Table 5].

3.5 Tablet friability

The friability test is the method to find the loss of product during transportation. The test was carried out using a tablet friability machine which is commonly used in pharmaceuticals tablet testing. All 10 tablets having same weights (650 mg/tablet) were selected. The drum was rotated 100 times. Tablets were removed and weighed. The % friability was calculated by the following formula. The % friability of detergent tablets having the disintegrating time of 2 min was better than the detergent tablet having the disintegrating time of 30 sec. [Table 6]. The loss of tablet was dependent on the composition of tablet composition and pressure is given to tablet during detergent compressed to the tabulated form. Composition and size of a tablet, the quantity of water played an important role in disintegration and dispersion. Minimum 15% starch was required along with 25% citric acid and sodium bicarbonate or silicic acid to disintegrate the tablet rapidly. The hardness of the tablet was due to the pressure applied during the compression of the detergent powder. Tablet hardness should be greater than 4.5 Kg/〖cm〗^2. The hardness of the tablet directly affected the friability test which, measured the loss during the transportation. The % loss during the transportation was less than 2%. Due to the compact form of powder its volume was reduced up to 50%, thus reduced packing and transportation costs. The rate of disintegration of the tablet was less than 30 seconds without appreciable energy. In the compact form, the powder particles are tightly bound, and the minimum part of the powder is contacted with the environment. Due to this, it doesn't catch moisture easily.

Table 1. The acid value of LABSA

Sr. No.	Sample	Weight of Sample	B.R.	Acid Value
1	**LABSA**	**2.25 gm**	**90 ml**	**225** $\frac{mg\ of\ KOH}{gm\ sample}$
2	**LABSA after neutralization**	**2.5 gm**	**0.0**	**0.0**$\frac{mg\ of\ KOH}{gm\ Sample}$

Table 2. Disintegration time of various formulated tablets

Sr. no.	Detergent powder (%)	Disintegrating agents (gm)				VOLUME OF WATER (ml)	DISINTEGRATION TIME
		Starch	Silicic Acid	Citric Acid	Sodium bicarbonate		
1	100	-	-	-	-	100	78 hrs.
2	70	30	-	-	-	100	50 hrs.
3	70	15	15	-	-	100	02 hrs.
4	60	15	25	-	-	100	02 hrs.
5	60	15	05	08	07	100	03min.
6	70	-	-	15	15	100	02 hrs.
7	60	15	-	15	10	100	03 min.
8	60	10		18	12	100	01min.

9	60	10	10	10	10	100	3.5min.
10	60	15	05	10	10	100	01min.
11	50	15	05	15	15	100	0.5 min

Table 3. Detergency (soil removal) of liquid detergency for soiled cotton fabric

SAMPLE	Concentration	% Detergency
Detergent Powder	0.1	63.19
	0.25	64.8
	0.5	72.59
Detergent tablet having disintegrating time 0.5 min.	0.1	62.45
	0.25	65.12
	0.5	72.43
Detergent tablet having disintegrating time 2.0 min.	0.1	59.32
	0.25	61.29
	0.5	63.84
Commercial detergent powder	0.1	44.19
	0.25	48.32
	0.5	53.11

Table 4. Foam stability and height of detergent tablet and powder

SAMPLE	Concentration	Time (min.)					
		0	**5**	**10**	**15**	**20**	**25**
		Height (cm)					
Detergent Powder	0.1	26.5	26.5	26.5	26.4	25.6	24.2
	0.25	26.5	26.5	26.5	26.1	24.8	24.0
	0.5	26.5	26.5	26.5	26.3	24.6	23.8
Detergent tablet having disintegrating time 0.5 min	0.1	26.5	26.5	26.5	25.6	25.0	23.8
	0.25	26.5	26.5	26.5	25.8	24.2	23.4
	0.5	26.5	26.5	26.5	24.5	24.0	22.8
Detergent tablet having disintegrating time 2.0 min.	0.1	26.5	26.5	26.5	24.5	24.5	24
	0.25	26.5	26.5	26.5	25.4	24	24
	0.5	26.5	26.5	26.5	25	25	24.5
Commercial detergent powder	0.1	23.2	23.2	22.4	22	22	21
	0.25	23.2	23.2	22.3	22	22	21.5
	0.5	23.0	23.0	22.3	22	22	21.5

Table 5. the wetting ability of samples

Sr. No.	Batch	Concentration (%)		
		0.5	**1**	**1.5**

1	Detergent Powder	55 Sec.	38 Sec.	32 Sec.
	Detergent tablet	63 Sec.	41 Sec.	38 Sec.
2	Commercial detergent powder	24 Sec.	25 Sec.	23 Sec.

Table 6. % Friability of tablets

Sr.no.	BATCH NO.	% Friability of tablet
1	Detergent tablet having disintegrating time 2 min	26.91
2	Detergent tablet having disintegrating time 30 sec.	2

4.0 Conclusion

Detergent tablets can be successfully used for the washing of fabric. They are consisting of active ingredients and disintegrating agents, which releases gases like carbon dioxide, oxygen, and hydrogen after contacting with enough water. One or two tablets are enough for the washing instead of one scoop. Effervescent tablets are convenient to use & handle and are preferred over existing forms. Detergent powder composition in the effervescent tablets contains 95% useful matter and disintegrates within 30 seconds at room temperature in water. The tablet detergent has shown better performance than various market detergents. Thus, detergent tablet compacts would have an added benefit of ease of conveniences.

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