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Development of Aloe Vera – Turmeric Tablets Formulation as a Food Product

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Abstract: Aloe vera (AV) and turmeric (T) were used in the development of chewable tables due to their high therapeutical benefit upon consumption. The study aims to produce and evaluate the physicochemical properties of Aloe vera powder (AVP), formulate chewable tablets with disintegration, hardness and taste-masking properties and also to investigate the quality control test, sensory acceptance and Antioxidant activity of the AV-T tablets. A dehydrator was used in achieving a physical stable of powdered form aloe vera gel. The AVP was compared with commercialized AVP (CAVP) to measure the physicochemical properties efficiency prior in tableting the tablets. Less densed of CAVP powder was obtained using the spray dryer compared to AVP using a dehydrator, where 5.371 (g/ml) ± 0.020 and 7.929 (g/ml) ± 0.050 of bulk and tapped density was observed opposed from the AVP with 10.673 ±0.052 (g/ml) and 11.525 ±0.018 (g/ml) for both bulk and tapped density respectively. Higher percentage value of Carr Index (CI) with 32.20 ±0.006 (%) was obtained from the CAVP indicates poor flowability. Next, 7.673% ±0.091 and 0.574% ±0.017 of moisture percentage and Aw were evaluated in AVP. Meanwhile, 5.890% ±0.297 and 0.201% ±0.123 of lower moisture and Aw respectively were observed in CAVP. The formulation on the AV-T tablet using the simplex lattice design method with the alteration between Microcrystalline cellulose (MCC) and mannitol (M) was conducted to aid in the development of a chewable AV-T tablet with better disintegration, hardness and taste-masking quality. The results related to the disintegration time and hardness of tablets was as F2> F4> F3> F5> F1, where F1 has a shorter disintegration time and smaller breaking force of tablet compare to F1. No significant different observe in sensory attributes except for sweetness ($p < 0.05$). MCC concentration also was observed in scavenging free radicals. The inhibition of the DPPH in tablet samples was observed to be increased upon higher level of MCC.

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The inhibition level shows an increased percentage from F1< F5< F3< F4< F2. The Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) result also corresponds with the inhibition percentage of free radicals, F2> F4> F3> F5> F1. The tablets produced showed satisfactory result with respect to most of the parameters evaluated.

Keywords: Aloe Vera Powder (AVP), Commercialized AVP (CAVP), Physicochemical Properties, Quality Control Tablet

1. Introduction

In the last few decades there has been an exponential growth in the field of herbal pharmaceutical. The scientific evidence on the health and therapeutic benefits present has brought the possibility of utilization of herbal plant in the production of pharmaceutical tablet. Aloe vera (AV) has been known for centuries with its therapeutic and medical advantages properties that bring healing properties to the user [1]. AV either uses for consumption as dietary supplement in tablet doses, sachet packet, liquid and powder foams or in the field of cosmetology such as cleaners, moisturizers, suntan lotion, tooth paste, gel and soaps.

Besides that, turmeric, a spice that has long been recognized for its medicinal properties, has received interest from both the medical/scientific world and from culinary enthusiasts [2]. This perennial plant is belonging to family Zingiberacceae, which distributed throughout the tropical and sub-tropical regions of the world [3]. Nowadays, various types of products have been produced from both of these ingredients (AV and turmeric) and one of them is supplements. Tablets are solid doses of pharmaceutical preparation that contain drug substances usually prepared with the aid of suitable pharmaceutical excipients. The research repeatability with the combination of both substances in a tablet production are still low, despite the widespread marketed tablet manufacturing of both AV and turmeric (T).

Oral routes of drug administration have wide acceptance up to 50-60% of total dosage forms. The popularity of solid dosage tablets is due to its ease of administration, accurate dosage, self-medication and an effective pain reliever [4]. Consuming tablet dosage assisted with water becoming a concern for some individual or patients, due to difficulty to swallow. Hence, this study on the development of Aloe vera- Turmeric (AV-T) tablet will be focused on the formulation of chewable tablet with better quality control test and taste-masking.

Determination on the physicochemical characterization on the Aloe vera powder (AVP) plays a major role in the drug or tablets medicine development process. Granule properties like flow ability, compressibility or disintegration plays an important role in the final performance of a tablet [5]. Such characteristic is important to be evaluated in producing tablet with better quality control properties. In this research, AVP was produced from gel (AVG) of *Aloe Barbandensis Miller* from Batu Pahat, Malaysia. The physicochemical characteristic of AVP was compared with the commercializes AVP (CAVP) prior in tableting tablets. Other than that, both AVP and CAVP was used in the development of AV-T tablets to compare the physicochemical effectiveness of the powder onto the tablets formulation. Alteration on MCC and mannitol also was studied in order to measures the response on properties of quality control of tablets and sensory acceptance. Antioxidant activity such as TPC, TFC and DPPH were performed to measure the antioxidant presence in AV-T tablets.

2. Materials and Methods

2.1 Materials

Aloe Vera plant was collected from Batu Pahat, Johor. Maltodextrin (≤ 20 DE, Antingredient) was used in the production of AVP [6].

2.2 Methods

Preparation of AVP. The filleting process of AVG was performed manually using a knife. Then, AVG was ground using a blender (Kenwood AT358 Thermoresist) and filtered manually using a mesh sieve strainer. The filtrate AVG was mixed with Maltodextrin with a ratio of 1:2 respectively and mixed well using a blender. The dehydrator was used in assisting the drying process. The mixture was dried for 24 hours at 60 ºC and then ground using a blender to form the uniform powder [7]. The powder was kept in an air-tight container before further used in this study.

2.3. Physicochemical Analysis of Powder

Determination of Bulk and Tapped Density. The determination of bulk and tapped density of the powder was measured using a 100 ml measuring cylinder [8]. A 30 g of powder sample was filled in the measuring cylinder. The bulk density was calculated using the formula (1) below:

$$\text{Bulk density} = \frac{Weight\ of\ sample\ (g)}{Volume\ of\ sample\ (ml)} \quad (1)$$

The tapped density was determined after 50 taps on a table from a height of 2 cm. The tapped volume of sample was noted. The tapped density was calculated as equation (2) below:

$$\text{Tapped density} = \frac{Weight\ of\ sample\ (g)}{Tapped\ volume\ of\ sample\ (ml)} \quad (2)$$

Determination of Carr's Index (CI). The Carr's Index of the powder sample was determine using the result obtained from both bulk and tapped densities. The CI equation (3) can be referred below:

$$\text{Carr's Index (CI)} = \frac{Tapped\ density\ \left(\frac{g}{ml}\right) - Bulk\ density\ \left(\frac{g}{ml}\right)}{Tapped\ density\ \left(\frac{g}{ml}\right)} \text{x100} \quad (3)$$

Determination of Moisture. The moisture content of the powder sample was determined using a moisture analyzer (Sartorious, Germany). A 3 g of sample was evenly distributed onto the tray and heated at 130 ± 1 ºC. The % value for the moisture was noted once the machine automatically halts [7].

Determination of Water Activity (Aw). The water activity of the sample was determined using a water activity meter (Aqualab, Decagon 3TE, Decagon Devices Inc., Pullman, WA) at 25 ºC [9].

2.4 Method and Formulation of AV-T Tablets

Table1 listed the ingredients and measurement used in the formulation of AV-T tablet. The listed items were based on the tablet diameter that compressed using a press tablet machine (Cadmach Machinery Ltd., Ahmedabad, India) fitted with 8 mm pound standard concave punches.

Table 1: The ingredient and measurement (mg) for the formulation of AV-T tablet

Ingredient (mg)	Weight Percentage (%)/ tablet	F1	F2	F3	F4	F5

Aloe vera powder (AVP)/Commercialized Aloe vera powder (CAVP)	30	114	114	114	114	114
Turmeric powder (TP)	0.5	1.9	1.9	1.9	1.9	1.9
Passion fruit powder	19	72.2	72.2	72.2	72.2	72.2
Citric acid	3.5	13.3	13.3	13.3	13.3	13.3
Sucralose	0.4	1.9	1.9	1.9	1.9	1.9
Lactose powder	25	95	95	95	95	95
Magnesium stearate powder	0.5	1.9	1.9	1.9	1.9	1.9
Talc powder	1	3.8	3.8	3.8	3.8	3.8
Microcrystalline cellulose (MCC)	20	0	57	38	76	19
Mannitol		76	19	38	0	57
Tablet weight	100	380	380	380	380	380

The Simplex lattice mixture design was used to formulate the AV-T tablet. The alteration on the MCC and mannitol (20% of weight tablet) was used in this study to measure the response between alteration of MCC and mannitol with the physical characteristic of tablets and its sensory acceptance. Table 2 shows percentage value of MCC and mannitol.

Table 2: The formula for MCC and mannitol in percentage (%)

Ingredient	F1	F2	F3	F4	F5
MCC (%)	0	15	10	20	5
Mannitol (%)	100	5	10	0	15

The same formulation was used to develop the AV-T tablet using the commercialized AVP (CAVP). This activity was performed to measure and evaluate the effectiveness of the physicochemical properties of powder to tableting tablet. All the ingredients were accurately weighed (Mettler Toledo B204-S) as stated in Table 1 and then sieved through a 1 mm mesh siever. All ingredients except magnesium stearate and talc were mixed in a large poly bag using tumbling action. The powders were further mixed with a glidant-lubricant blend containing magnesium stearate and talc for 5 minutes. The blend then was compressed manually using 8mm pressed tablet machine and dried using a dehydrator for an hour at 60 ºC [10]. All the tablets were kept in an air-tight container before used in further analysis.

2.5 Quality Control Test on AV-T Tablets

Weight Uniformity Test. Tablet (n=20) were selected randomly from each formulation and weighed individually using weighing balance (Mettler Toledo, Switzerland). The mean weight and standard deviation of the tablets was then measured [7].

Thickness and Diameter. These properties were measured using an a vernier caliper. The mean and standard deviation thickness and diameter of the tablets were then measured [7].

Hardness Test. (n=3) The tablet hardness test using a 25 cm cylindrical probe (TA.XTplus Texture analyzer). The kg/(Force) needed to break down the tablets was recorded [7].

Disintegration Time. The tablets were randomly selected (n=6) and placed individually in the six tubes of the disintegration machine (Erweka, Germany).

2.6 Sensory Analysis

The acceptance test was performed using the 9-point scaling methods. 50 untrained panellists were involved in this test [11].

2.7 Antioxidant Analysis

Determination of 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. A standard gallic acid curve was constructed by preparing the dilutions of (0.1, 0.5, 1.0, 2.5 and 5 mg/ml) in methanol from a 1% solution of Gallic acid (10mg/ml) [13]. DPPH activity was analysed at 515 nm. The inhibition (%) was calculated and measured [14].

Determination of Total Phenolic Content (TPC). A gallic standard acid was prepared as above. The TPC presence was absorbed at 760 nm using UV-Vis Spectrophotometer [12].

Determination of Total Flavonoid Content (TFC). Quercetin standard was prepared. TFC absorbance was recorded at 510 nm using UV-Vis Spectrophotometer [12].

3. Results and Discussion

3.1 Physicochemical Analysis of Powder

Based on Table 3, the bulk and tapped density of AVP observed was 10.673 (g/ml) ± 0.052 and 11.525 (g/ml) ± 0.018 respectively. Less densed of CAVP powder was obtained using the spray dryer compared to AVP using a dehydrator, where 5.371 (g/ml) ± 0.020 and 7.929 (g/ml) ± 0.050 of bulk and tapped density was observed opposed from the AVP with 10.673 ±0.052 (g/ml) and 11.525 ±0.018 (g/ml) for both bulk and tapped density respectively. Higher percentage value of CI with 32.20 ±0.006 (%) was obtained from the CAVP indicates poor flowability [13]. CI values represent the flowability properties of powder. The poor flowability of CAVP could be explained by a small particle size of powder obtain using spray dry machine. A fine particle size of food powders led to poor flow properties [14]. Smaller size will cause lower density. Decrease in particle size will increase the cohesion and reduce the flowability powder. High-end spray dry machine able to produce very fine particle powder form product [15]. Atomizer used in the spray dry machine able to transform the solution, dispersion, or emulsion into a spray with a prescribed drop size [16]. Next, a 7.673% ±0.091 and 0.574% ±0.017 of moisture percentage and Aw were evaluated in AVP. Meanwhile, 5.890% ±0.297 and 0.201% ±0.123 of moisture and Aw respectively were observed in CAVP. Low moisture content and Aw activity in CAVP may resulted from higher temperature processing method [17]. As higher temperature (> 100 ºC) used in spray dry compare to the food dehydrator with maximum drying heat <80 ºC.

Table 3: The physicochemical analyses between Aloe vera powder (AVP) and commercialized Aloe vera powder (CAVP)

No	Ingredient	Bulk density (g/ml) ±SD	Tapped density (g/ml) ±SD	Carr's Index (CI) (%) ±SD	Moisture (%) ±SD	Water activity (Aw) (%) ±SD
1	Aloe vera powder (AVP)	10.673 ±0.052	11.525 ±0.018	7.300 ±0.006	7.673 ±0.091	0.574 ±0.017
2	Commercialized Aloe vera powder (CAVP)	5.371 ±0.020	7.929 ±0.050	32.20 ±0.006	5.890 ±0.297	0.201 ±0.123

3.2 Quality Control Test of AV-T Tablets

Table 4: Quality control test on AV-T tablets made up with AVP

Formulation	Weight uniformity (mg ± SD)	Thickness (mm ± SD)	Diameter (mm ± SD)	Hardness (kg/F ± SD)	Disintegration time (min ± SD)
F1	378.854 ± 0.040	5.067 ± 0.024	8 ± 0.000	15.335 ± 0.343	23.965 ± 0.514
F2	378.791 ± 0.088	5.017 ± 0.024	8 ± 0.000	8.033 ± 0.262	12.557 ± 0.028
F3	378.888 ± 0.021	5.017 ± 0.024	8 ± 0.000	12.129 ± 0.446	18.147 ± 0.086
F4	378.924 ± 0.018	5.017 ± 0.024	8 ± 0.000	9.843 ± 0.419	15.532 ± 0.040
F5	378.989 ± 0.021	5.017 ± 0.024	8 ± 0.000	13.618 ± 0.175	22.343 ± 0.104

Table 5: Quality control test on AV-T tablets made up with CAVP

Formulation	Weight uniformity (mg ± SD)	Thickness (mm ± SD)	Diameter (mm ± SD)	Hardness (kg/F ± SD)	Disintegration time (min ± SD)
F1	377.889 ± 0.004	5.067 ± 0.024	8 ± 0.000	11.328 ± 0.603	15.925 ± 1.038
F2	377.966 ± 0.007	5.017 ± 0.024	8 ± 0.000	7.518 ± 0.084	8.956 ± 0.052
F3	377.908 ± 0.038	5.017 ± 0.024	8 ± 0.000	8.404 ± 0.082	10.763 ± 0.0936
F4	377.941 ± 0.039	5.017 ± 0.024	8 ± 0.000	7.966 ± 0.053	9.883 ± 0.061
F5	377.951 ± 0.040	5.033 ± 0.024	8 ± 0.000	9.818 ± 0.059	14.055 ± 0.028

Table 4 shows the weight uniformity of AV-T tablet made with AVP was in the range of 378.791 mg to 378.989 mg with $p < 0.05$. Meanwhile, there is no significant ($p > 0.05$) different in tablets made with CAVP. There was a significant different result in the alteration of both MCC and mannitol on both formulations. Alteration of MCC and mannitol show a significantly different ($p < 0.05$) for both hardness and disintegration time of the tablets. For AVP, the hardness ranges from 8.033 kg/F to 15.335 kg/F. The hardness for the F1, F3 and F5 was observed to be over the limit of the recommended hardness force (< 12kg/F) from FDA guidance for a chewable tablet [18]. Differ from AVP, the hardness tablets content of the CAVP was observed to be below the limit prescribed by FDA. An increase in MCC value will increase the disintegration time [19]. The hardness force to break down the tablet and disintegration time corresponds with one another. Increasing the hardness of tablets will increase the disintegration time of tablet. Lower density powders promote lesser and shorter breaking force and disintegration time. In conclusion, the results related to the disintegration time and hardness of tablets was as F2> F4> F3> F5> F1, where F1 has a shorter disintegration time and smaller breaking force of tablet compare to F1. As the tablet formulation content with CAVP has shown an overall result with faster disintegration time and lower breaking force of tablet in the quality control compared to the AVP, tablets formulation containing CAVP was used for further analysis in this study.

3.3 Sensory Analysis

Table 6: Sensory analysis on AV-T tablets

Formulation	Appearance	Colour	Odour	Texture	Sweetness	Sourness	Overall acceptance
F1	8.250 ± 0.433	8.500 ± 0.866	6.143 ± 1.245	5.429 ± 0.728	8.286 ± 0.990	7.857 ± 0.990	8.000 ± 1.195
F2	8.250 ± 0.829	8.000 ± 0.707	5.286 ± 1.666	8.00 ± 0.535	5.429 ± 0.904	4.429 ± 1.294	4.571 ± 1.400
F3	6.750 ± 0.829	7.500 ± 1.118	5.857 ± 1.641	7.143 ± 0.639	6.429 ± 1.294	6.286 ± 1.485	6.714 ± 1.030
F4	7.750 ± 0.433	8.250 ± 0.433	5.000 ± 1.195	7.143 ± 0.639	6.143 ± 0.833	6.143 ± 1.552	6.667 ± 0.943
F5	6.750 ± 0.829	7.250 ± 0.829	5.143 ± 0.639	5.174 ± 0.700	7.429 ± 0.904	7.429 ± 0.904	7.429 ± 1.178

Table 6 shows the result obtained from the sensory evaluation. The result shows no significant difference obtained with $p>0.05$ for every attribute except for the sweetness ($p<0.05$). This showed that the panellist was unable to distinguish the alteration on the MCC and mannitol. The appearance attribute ranges from 6.750 to 8.250. Meanwhile, the range for colour attribute falls within 7.250 to 8.500. Lower ranges of acceptance for odour were evaluated from the sensory analysis (5.000 to 6.143). The texture acceptance for the sensory evaluation ranges from 5.174 to 8.000. Formulation 2 with the lowest breaking forces and faster disintegration time was chosen as the best texture. For the sweetness attributes, most of the panellists (8.286 ± 0.990) choose F1 as their preference. The sourness attribute ranges from 4.429 to 7.857. F2 with the highest mannitol present was evaluated with the least mean (4.429 ± 1.294). In conclusion, the overall acceptance of the AV-T tablets formulation was as F1> F5 > F3 > F4 >F2.

3.4 Antioxidant Analysis

Table 7: Inhibition (%) of DPPH for both Gallic acid and AV-T tablets formulations

Concentration (mg/ml)	Inhibition % (Gallic acid)	Inhibition % (AV-T tablet formulation)
0.2	96.60 ±0.003	79.80 ±0.009
0.4	94.53 ±0.007	86.70 ±0.044
0.8	93.80 ±0.009	81.40±0.004
2	88.40 ±0.008	81.50 ±0.023
4	76.13 ±0.005	80.70 ±0.020

Table 8: TPC (mgGAE/g) on AV-T tablets formulation

Formulation	TPC (mgGAE/g)
F1	2.829 ± 0.090
F2	3.652 ±0.110
F3	3.232 ± 0.053
F4	3.410 ± 0.098
F5	2.936 ± 0.053

Table 9: TFC (mgQE/g) on AV-T tablet formulations

Formulation	TFC (mgQE/g)
F1	0.248 ± 0.029
F2	0.384 ± 0.08
F3	0.357 ± 0.004
F4	0.376 ± 0.014
F5	0.261 ± 0.081

The high scavenging activity of tablets formulation due to the high content of phytochemical. MCC concentration also was observed in scavenging free radicals. The inhibition of the DPPH in tablet samples was observed to be increased upon higher level of MCC (Table 7). The inhibition level shows an increased percentage from F1< F5< F3< F4< F2. Higher concentration of MCC could scavenge higher DPPH free radicals [20]. The TPC values range from 2.829 to 3.652 mgGAE/g. The TFC values range from 0.248 to 0.384 (mgQE/g). The TPC and TFC results (Table 8 and 9) also corresponds with the inhibition percentage of free radicals, F2> F4> F3> F5> F1. Thus, all the tablet formulations can be used as a natural antioxidant proven in this study.

4. Conclusion

The findings of the current study show a significant impact of physicochemical properties of powder on the final quality of solid tablet dosage. Advanced drying method such as spray dry produces better powder properties compared to dehydrator drying. Higher temperature assisted during drying will provide powder with lower moisture content and water activity. Spray dried CAVP shows an overall of better-quality control properties compare to AVP. The aim of this study to evaluate the physicochemical properties of powder was achieved. The quality of chewable AV-T tablet with better disintegration and taste masking obtained was correlated with the alteration of MCC and mannitol in this study. Indicates that utilizing MCC can improves the mechanical and physical properties of tablets. MCC concentration also was observed in scavenging free radicals. The TPC and TFC result also corresponds with the inhibition percentage of free radicals, F2> F4> F3> F5> F1. The tablets produced showed satisfactory result with respect to most of the parameters evaluated. The results of this study indicates that the chewable AV-T tablet formulation can be used as a food product development.

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