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Physico-chemical, nutritional, and sensory properties of chocolate made with date palm fruit (*Phoenix dactylifera*) powder as substitute for refined sugar

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Abstract:

This study focuses on date fruit, an underutilized but nutritionally rich resource, as a potential substitute for refined sugar in chocolate production. With 0%, 50%, 75%, 87.5%, and 100% sugar replacement and using standard methods, quality attributes of chocolate produced were datermined. The ranges of values obtained were: carbohydrate:(57.48–63.59%), crude protein: (8.66–10.05%), crude fat: (21.15%–23.56%), crude fiber:(1.46%–2.49%), ash: (1.78–2.81%), phytate and oxalate(0.0019–0.0056 g/kg and 3.90–5.92 mg/100g, respectively), L*, a*, and b*: (23.57–24.70, 6.24–6.47, and 3.37–3.77, respectively), the pH: (6.11 - 6.23),energy values: (479.35-483.96 kcal). Date fruit powder significantly (P=0.05) augmented the potassium (410.84–536.65 mg/100g), iron (3.32–8.61 mg/100g), sodium (92.46–140.70 mg/100g), calcium (122.70–174.82 mg/100g), magnesium (107.83–147.30 mg/100g), and phosphorous (110.70–168 mg/100g) contents of the chocolate samples. Texture profile values ranged from 265 to 467.67 (hardness), -84.30 to -123.00 g.mm (adhesiveness), -44.91 to -55.67 g (stickiness), 27.33 to 51.50 N.mm (chewiness), and 21.10 to 64.67 g (gumminess). Panelists prefered 50% date fruit powder, rating it higher in terms of color (7.87), taste (7.40), mouthfeel (6.87), aroma (7.20), and overall acceptability (7.53). The results suggests that date fruit powder could be a nutritious and viable sugar substitute in confectionery products such as chocolate.

Keywords: Chocolate, Date Fruit, Sugar, Physico-chemical, Nutritional Properties.

Introduction

The escalating consumption of refined sugar has evolved into a daily addiction, contributing to the global obesity epidemic, as declared by the World Health Organization (Khalid et al., 2017). Sugar refining, a process extracting over 99.9 percent sucrose, results in table sugar, lacking essential nutrients such as vitamins, minerals, proteins, or fiber (Becket, 2019). Excessive refined sugar intake poses risks to vital organs, leading to health issues like diabetes, cancer, and dental problems (Weber and Clavin, 2006). Moreover, sugar negatively impacts vitamin and minerallevels in the body due to its demands on digestion, detoxification, and elimination (Barimah, 2015).Confectioneries, a significant component of daily snacks, often contain high levels of refined sugar, raising health concerns. Developing products with natural sugars, providing nutrients like fiber, vitamins, and minerals, becomes imperative to mitigate health risks associated with refined sugar consumption (American Dietetic Association, 2006).Fruits, constituting a substantial portion of global agricultural output, are rich in essential nutrients and phytochemicals for long-term cellular health (Nehidi, 2018). Despite abundant fruit production, significant post-harvest losses occur in developing countries (Barimah, 2015), highlighting the need for further processing or incorporation into other products. The date palm, Phoenix dactylifera, yields edible sweet fruits rich in fiber, vitamin A, potassium, calcium, and various B vitamins, making it a promising substitute for refined sugar in confectioneries (Al-Farsi et al., 2008). The date fruit also contains natural sugars—8.2% sucrose, 23.7% fructose, and 32% glucose—enhancing its potential as a refined sugar alternative (Dicaguo et al., 2017).Chocolate, derived from cocoa tree fruits (*Theobroma cacao*), is consumed in various forms. While primarily an energy source, chocolate contains minor nutrients, with health benefits associated with cardiovascular disease prevention (Ding et al., 2006). The study explores the potential of date fruit powder as a refined sugar substitute in chocolate, aiming to identify alternatives rich in essential nutrients and promote the utilization of date fruits. Previous research has delved into alternative sweeteners (Jardine et al., 1990 and Erukainure et al., 2010), and this investigation contributes to the quest for healthier sugar substitutes with added nutritional value.

Materials and Methods.

Procurement of Materials**:** Cocoa beans, date palm fruit, and refined sugar were purchased from an open market in Ibadan. Food-grade chemicals, apparatus, and equipment were obtained from the Food Science and Technology Laboratory, Bowen University, Iwo.Date fruits were washed, seeds removed, and pulp dried at 60 °C for three days until a constant weight was achieved. The dried date was milled, sieved (250 µ), and stored in polyethylene bags at room temperature (Erukainure et al. 2010).

Preparation of Chocolate**:**

Preparation of Chocolate was carried out using the methods described by Sein *et al*. (2009). Subsequently, chocolates were wrapped in aluminum foil and stored at 18^{o}C for further analysis.Proximate Analyses**:** Moisture, ash, crude fat, protein, and fiber were determined by AOAC methods (2005). Total carbohydrates were calculated by difference.Physico-Chemical Properties:Determination of Colour.The color parameters (L*, a*, b*) were measured using a Digital Spectrophotometer (Mini Scan E2, Hunterlab. USA) after scanning the homogenous samples. The determination was carried out in triplicates (Fan et al., 2005).Determination of pH. pH was measured using a pH meter(Model CH12209, Hanna Instrument, USA.) after standardization with buffer solutions 7.0 and 4.0. The determination was carried out in triplicates.

Determination of Texture Profile: Texture profile parameters (hardness, chewiness, stickiness, adhesiveness, and gumminess) were determined using a texture analyzer(Model TVT 6700 ,Perten Instrument, Australia). The sample was subjected to double compression at a speed of 10 mm/s using a 50 N load cell. Chocolate bar dimensions were 2.5 cm x 2.5 cm x1 cm(l x w x h) (Shahanas et al., 2020).Energy Value**:** The energy content of chocolates was calculated as kilocalories using the equation: Energy (kcal) = (4 x Protein) + (4 x Total carbohydrates) + (9 x Fat) (Shahanas et al., 2020).

Determination of Mineral Contents: Minerals were ashed at 600 °C for 3 hours. Calcium, magnesium, iron, potassium and sodium were determined using Atomic Absorption Spectrophotometer (Model Alpha-4-atomic Absorption Spectrophotometer, Cole-partner Instrument Company, Chicago Illinois 6006), Phosphorus content was determined using Vanadomolybdate method (A.O.A.C., 2005).Determination of Total Soluble Solids**:** The degree of Brix of chocolate samples was determined using a calibrated refractometer after mixing with distilled water (Gunaratne et al., 2019).Determination of phytochemicals**:**Phytate and oxalate contents were determined using the official methods of AOAC (2005).

Sensory evaluation: 20 trained sensory panelist members were used and a 9-point hedonic scale used to evaluate taste, mouthfeel, aroma, color, and overall acceptability of chocolate samples.

Statistical Analysis**:** All data were subjected to one-way analysis of variance (ANOVA) using IBM SPSS Statistics 16. Means were separated using Duncan and LSD tests with a significance level of 0.05.

Name of Research Ethics Committee that approved the research: BUTH Research Ethics Committee

Registration number: NHREC/12/04/2012

Approval number: BUTH/REC-1061

Results and Discussions:

Chemical Composition of the Chocolate Samples:The results for chemical composition were as shown in Table 1. The moisture contents of the chocolate samples exhibited a range from 3.36% to 3.61%. Notably, the sample with 100% refined sugar demonstrated the lowest moisture content, while sample containing 15% date powder, exhibited the highest (Table 1). Statistical analysis revealed a significant difference (P=0.05) in the moisture content among the chocolate samples. The observed increase in moisture content with higher substitution levels is likely attributed to the hygroscopic nature of date fruit (Bonner, 2008). It is noteworthy, however, that the moisture content of all chocolate samples remained within acceptable levels.The ash content of the chocolate samples varied between 1.78% and 2.81%. Comparatively, the chocolate sample with 100% refined sugar showed the lowest ash content, while the sample with 100% date powder exhibited the highest ash content. This observation aligns with the inherently higher ash content in date powder as opposed to refined sugar. The range of ash content in the chocolate samples underscores the influence of the substitution level on this parameter, with values falling within the range of 1.78% to 2.81% (Table 1). Ashe content is usually an indicator of presence of minerals. A significant difference was observed between the control sample and the other formulations and this can be attributed to the date powder (Adubofuor and Amoafo, 2012). The protein contents of the chocolate samples ranged from 8.66 to 10.05% with the lowest in the sample made with 100% refined sugar. There is a significant difference (P=0.05) between the entire samples. The crude protein increased as the amount of the date powder increased; this may be attributed to the fact that date powder has a higher protein content than refined sugar. The fat contents ranged from 21.15 to 23.56%. The lowest value was observed in control sample with 100% refined sugar (21.15%) and the highest value of 23.56% in the chocolate sample containing 100% date powder. It was observed that the fat content increased as substitution with date powder increased. There was a significant difference (P= 0.05) in the crude fibre contents of the samples. The crude fibre content ranged from 1.46% to 2.49%. The crude fibre content was lowest in the sample composed of 100% refined sugar (1.46%) and the highest content in the sample composed of 100% date powder. Date powder significantly increased the crude fibre of the chocolate samples. The carbohydrate content ranged from 57.48% to 63.59%, with the lowest in the sample with 100% date powder (57.48%) and the highest content in the sample with 100% refined sugar. The carbohydrate content decreased with increasing date powder because as the other proximate parameters increased, the carbohydrate content decreased. This could be attributed to the complex nature of sugars and other carbohydrates present in the date fruit. The Phytic acid concentrations in the samples ranged from 0.0019 to 0.0058g/kg. Notably, the sample containing 100% refined sugar exhibited the lowest phytic acid content, while the sample with 100% date powder showed the highest value. Phytic acid functions as a potent chelator, forming complexes with proteins and minerals, ultimately leading to decreased bioavailability of both. It is known to chelate metal ions, including calcium, magnesium, zinc, copper, iron, and molybdenum, resulting in the formation of insoluble complexes that are poorly absorbed in the gastrointestinal tract (Akande, 2010). The oxalate contents in the chocolate samples ranged from 3.90 to 5.92mg/100g . The sample comprising 100% refined sugar exhibited the lowest oxalate content, while the sample with 100% Date Powder had the highest value. It is worth noting that all samples remained within acceptable levels of daily intakes in adults for both phytate(200-500mg/day) and oxalate(50-200mg/day), as reported by Ahmed *et al*. (1995). Physicochemical properties chocolate Samples

Colour of chocolate samples: Table 2 shows the instrumental colour evaluation of chocolate. Colour is an index essential for assessing the quality of chocolate. It is a strong determinant factor that plays a major role in the acceptability of chocolate. There were significant differences (P= 0.05) in L, a*, and b* values of the chocolate sample. The L* value represents lightness with the value ranging from 100=white and 0=black while a* represents red (positive), and green (negative), and b* represents yellow (positive), and blue (negative). The L* value ranged from 23.57 to 24.70. L* value was lowest in sample composed of 100% Date powder, and the highest value in sample with 100% of sugar. The decrease in the lightness of each sample at each level of substitution may be due to the darker colour of date fruit powder compared to refined sugar. The a* value ranged from 6.24 to 6.47. The a* value was highest in both samples L96 and T24 and the lowest value in the sample composed of 100% refined sugar. The b* value ranged from 3.37 to 3.77. The b* value was highest in sample formulated with 100% date powder and the lowest value was 1(3.37) in sample S58 composed of 100% refined sugar.Physico-chemical Properties of the Chocolate Samples**:**The physico-chemical properties of the chocolate samples are summarized in Table 3.The pH values of the chocolate samples exhibited a range from 6.11 to 6.23. The sample with 100% refined sugar demonstrated the highest pH, while the sample with 12.5% refined sugar exhibited the lowest. Notably, all chocolate samples displayed a slightly acidic nature. This pH range is slightly lower than the 6.3-6.7 range reported in the literature (Erukainure et al., 2010), and this deviation could be attributed to the inherently low pH value of date fruit (Shahanas et al., 2020).The energy values of the chocolate samples varied from 479.35 to 483.96 kcal. Samples with 25% and 50% sugar exhibited the highest calorific values (483.96 and 483.92 kcal, respectively), while the sample containing 100% sugar showed the lowest calorific value (479.35 kcal).The Brix values of the chocolate samples ranged from 10.07 to 10.33. The sample containing 100% date powder displayed significantly higher Brix values compared to other samples, whereas the lowest Brix value was recorded in the sample with 100% refined sugar.Mineral contents of Chocolate Samples.

The mineral composition of the chocolate samples (presented in Table 4): The values revealed significant variations in calcium, iron, magnesium, potassium, sodium, and phosphorus content. The results were statistically significant at a 5% level of significance.

Calcium Content: The chocolate sample with 100% Date Powder exhibited the highest calcium content (174.82mg/100g), while the sample with 100% refined sugar had the lowest value (122.70mg/100g). The inclusion of date powder led to a proportional increase in calcium content, with a notable 21% rise from the control sample (0% date powder) to the formulation with 50% Sugar + 50% Date Powder. Calcium is crucial for skeletal mineralization and various biological functions, and the abundant presence of calcium in date fruit contributes significantly to its nutritional value (Peacock, 2010).

Iron Content: Significant differences in iron content were observed among the chocolate samples ($P<0.05$). The sample formulated with 100% date powder recorded the highest iron content (8.61mg/100g), showing a substantial 75% increase from the control sample to the formulation with 50% date powder. Iron plays a vital role in growth and development, being essential for hemoglobin production and oxygen transport in red blood cells. Iron is stored in various tissues, including muscles, bone marrow, liver, and spleen (Adubiaro et al., 2011).

Magnesium Content: The chocolate sample with 87.5% date powder exhibited the highest magnesium content (147.30mg/100g), while the sample with 100% refined sugar had the lowest value. Magnesium is essential for energy metabolism, nerve transmission, and muscle and heart contraction, as well as RNA and DNA synthesis (Adubiaro et al., 2011).

Potassium Content: Significant differences were noted in the potassium content of the chocolate samples, with the highest value (536.65mg/100g) observed in the sample with 100% date powder and the lowest (410.84mg/100g) in the sample with 100% refined sugar. The incorporation of date powder increased the potassium content at different levels of addition. Potassium, being the major mineral recorded in the chocolate, is indicative of date fruit's potency as a good source of potassium, aligning with findings by Al-Farsi and Lee (2008). Potassium contributes to normal nerve function, muscle control, fluid regulation, and aids in preventing high blood pressure.

Sodium Content: A significant difference in sodium content was evident among the chocolate samples. The sample with 87.5% date powder had the highest sodium content (140.70mg/100g), while the sample with 100% refined sugar had the lowest value. Increased addition of date powder led to higher sodium content at varying levels. Sodium is essential for nerve impulse conduction, muscle function, and maintaining water and mineral balance in the body.

Phosphorus Content: Significant differences in phosphorus content were observed (P=0.05), with the highest value (168mg/100g) in the sample containing 100% date powder and the lowest in the sample with 100% refined sugar. Phosphorus, the second most abundant mineral in the body, plays a crucial role in bone and teeth formation, carbohydrate and fat utilization, and protein synthesis for cell growth, maintenance, and repair. The inclusion of date powder increased the phosphorus content at different levels of addition.The sample containing 100% refined sugar exhibited the lowest phosphorus value in Table 4. Phosphorus, being the second most abundant mineral in the body, serves a pivotal role in bone and teeth formation. Additionally, it plays a crucial function in the body's utilization of carbohydrates and fats. Furthermore, phosphorus is essential for the synthesis of proteins, contributing to the growth, maintenance, and repair of cells and tissues.

Chocolate Texture Profile: The findings of the texture profile analysis are presented in Table 5. The hardness measurements exhibited a range of values from 265.33 to 467.67. The sample containing 100% date powder demonstrated the highest hardness, whereas the control sample with 100% refined sugar exhibited the lowest. This implies that an increase in date powder substitution led to heightened product hardness, as hardness is defined by the force required to deform the product to a specified distance. Adhesiveness measurements ranged from -84.30 to -123.00 g.mm, with significant differences observed among all samples. The sample comprising 100% date powder recorded the lowest adhesiveness value (-84.30 g.mm), while the sample with 100% refined sugar recorded the highest (123.00 g.mm). A notable difference (P=0.05) in stickiness was observed among the samples, varying from -44.91 to -57.67. The sample composed entirely of date powder exhibited the lowest stickiness (-44.91g), while the sample with 100% refined sugar showed the highest (-57.67g).Chewiness measurements ranged from 27.33 to 51.50 mm, indicating a significant difference between samples. The highest chewiness value (51.50 Nmm) was observed in the sample with 100% refined sugar, while the lowest (27.33 N.mm) was found in the sample with 100% date powder. Gumminess measurements also demonstrated a significant difference among chocolate samples, ranging from 21.10 to 64.67g. The lowest gumminess value (21.10g) was recorded in the sample with 100% date powder, while the control sample with 100% refined sugar exhibited the highest gumminess (64.67g).Sensory evaluation results for chocolate samplesThe sensory evaluation outcomes for chocolate samples are presented in Table 6. Statistical analysis at the (P=0.05) level revealed no significant differences among the means of all samples. The highest rating for color (7.87) was assigned to the sample with a formulation of 50% sugar + 50% date powder, while the lowest rating (5.73) for taste was observed in the sample composed entirely of 100% date powder. Taste preference was notably higher at the 50% substitution level compared to other substitutions, and the product with 100% date powder was the least favored. This taste variation may be attributed to certain components, such as flavonols or phenolic compounds present in the date fruit (Borochov-Neori et al., 2015).Mouth-feel evaluations indicated no significant differences among the samples, with the sample containing 87.5% date powder being the most preferred, followed by the sample with 50% date powder, the sample with 100% date powder was the least preferred in terms of mouth-feel, suggesting an impact of date powder on chocolate texture.Color scores ranged from 7.40 to 7.87 with no significant differences at ($P<0.05$) compared to other chocolate samples. The highest color rating (7.87) was assigned to the sample formulated with 50% sugar + 50% date powder, while the lowest (7.40) was observed in the chocolate sample with 100% date powder.In terms of aroma, the chocolate sample made with 100% date powder received the lowest rating (6.53), whereas the sample composed of 12.5% sugar + 87.5% date powder had the highest score (7.47).For overall acceptability, the sample containing 50% date powder was the most preferred by panelists, suggesting that overall acceptability was influenced by various parameters. In contrast, the sample with 100% date powder was the least accepted, receiving a mean score of 6.67

Conclusion and Recommendation.

Conclusion:This study explored the potential of date fruit powder as a substitute for refined sugar in chocolate production. The results revealed that an increase in date powder substitution led to elevated levels of crude protein, crude ash, and fiber in the chocolate product. Sensory evaluations demonstrated variations in preferences across different substitution levels for parameters such as color, taste, aroma, mouthfeel, and overall acceptability. The 50 percent substitution level consistently yielded the most preferred products. Furthermore, the study found significantly higher mineral content (Ca, K, Mg, P, Na, and Fe) in the product with 50 percent substitution.Recommendation:Based on the sensory and nutritional qualities identified in this study, the following recommendations are made:Utilization of Date Powder: Date powder, recognized as a rich source of fiber and minerals, should be employed as a refined sugar substitute in chocolate manufacturing.Optimal Substitution Level: Considering the study's findings, it is recommended to substitute refined sugar in chocolate production with date fruit powder at a 50 percent level. This balance enhances the utilization of date fruit while reducing reliance on refined sugar in confectionery products.

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The tables:

Table 1: Chemical composition of Chocolate Samples

Sample	Moisture (%)	Ash(%)	Protein(%)	Fat(%)	Fibre(%)	Carbohydrates(%)	Phytate (g/kg)	Oxalate (mg/100g)
S58	3.36±0.02[d]	1.78±0.04[e]	8.66±0.09[d]	21.15±0.09[c]	1.46±0.06[e]	63.59±07[a]	0.0019±0.00046[c]	3.90±0.29[c]
D15	3.61±0.03[a]	2.81±0.03[a]	10.05±0.20[a]	23.56±0.05[a]	2.49±0.08[a]	57.48±0.17[e]	0.0058±0.00038[a]	5.92±0.56[a]

L96	3.40±0.02[c]	1.94±0.04[d]	9.05±0.15[c]	22.48±0.22[b]	1.78±0.07[c]	61.35±0.30[b]	0.0041±0.00056[b]	4.39±0.18[b]
P73	3.52±0.03[b]	2.24±0.05[c]	9.37±0.20[b]	22.72±0.09[b]	1.65±0.05[d]	60.50±0.01[c]	0.0047±0.00036[b]	5.84±0.43[a]
T24	3.59±0.02[a]	2.55±0.04[b]	9.47±0.11[b]	23.05±0.09[a]	2.07±0.04[b]	59.27±0.13[d]	0.0051±0.00030[a]	5.88±0.37[a]

Values are mean± SD of triplicate; Duncan separation of means with same alphabets are not significantly different

($p<0.05$) in each column. **S58:** 100% Refined sugar, **D15:** 100% Date powder**, L96:** 50% Refined sugar + 50% Date powder, **P73:** 25% Refined sugar + 75% Date Powder, **T24:** 12.5% Refined sugar + 87.5% Date powder

Table 2: Colour Attributes of Chocolate Samples

Sample	L	a*	b*
S58	24.70±0.20[a]	6.24±0.07[b]	3.37±0.05[b]
D15	23.57±0.03[c]	6.41±0.06[a]	3.77±0.08[a]
L96	24.00±0.02[b]	6.47±0.09[a]	3.48±0.11[b]
P73	23.49±0.10[c]	6.40±0.06[a]	3.50±0.09[b]
T24	23.68±0.14[c]	6.47±0.07[a]	3.49±0.06[b]

Values are mean± SD of triplicate; Duncan separation of means with same alphabets are not different ($p<0.05$) in

each column: **S58:** 100% Refined sugar, **D15:** 100% Date powder**, L96:** 50% Refined sugar + 50% Date powder, **P73:** 25% Refined sugar + 75% Date Powder, **T24:** 12.5% Refined sugar + 87.5% Date powder.

Table 3: Physicochemical Properties of Chocolate Sample.

Sample	pH	Brix($^{O)}$	Energy value(kcal)

S58	6.23 ± 0.03^{a}	10.07 ± 0.06^{b}	479.35 ± 0.22^{c}
D15	6.14 ± 0.05^{bc}	10.33 ± 0.06^{a}	482.08 ± 0.49^{b}
L96	6.20 ± 0.05^{ab}	10.20 ± 0.00^{a}	483.92 ± 1.25^{a}
P73	6.12 ± 0.04^{bc}	10.23 ± 0.06^{a}	483.96 ± 0.81^{a}
T24	6.11 ± 0.01^{c}	10.27 ± 0.17^{a}	482.41 ± 0.32^{b}

Values are mean± SD of triplicate; Duncan separation of means with same alphabets are not different ($p<0.05$) in

each column: **S58:** 100% Refined sugar, **D15:** 100% Date powder**, L96:** 50% Refined sugar + 50% Date powder, **P73:** 25% Refined sugar + 75% Date Powder, **T24:** 12.5% Refined sugar + 87.5% Date powder.

Table 4: Mineral composition of chocolate samples. (mg/100g)

Sample	Calcium	Iron	Magnesium	Potassium	Sodium	Phosphorus
S58	122.70±0.10[e]	3.32±0.25[d]	107.83±0.62[d]	410.84±0.54[e]	92.46±0.25[d]	110.70±0.47[e]
D15	174.82±0.21[a]	8.61±0.09[a]	146.79±0.66[a]	536.65±0.69[a]	140.05±0.14[a]	168.00±0.30[a]
L96	148.98±0.36[d]	5.811±0.50[c]	124.23±0.38[c]	491.34±2.49[d]	105.05±0.73[c]	140.52±0.43[d]
P73	157.09±0.29[c]	6.17±0.14[bc]	138.85±0.44[b]	138.85±0.44b	123.22±0.82[b]	148.30±0.48[c]
T24	172.17±0.18[b]	6.54±0.40[b]	147.30±0.27[a]	511.18±0.81[b]	140.70±0.18[a]	163.39±0.75[a]

Values are mean± SD of triplicate; Duncan separation of means with same alphabets are not different ($p<0.05$) in each column. **S58:** 100% Refined sugar, **D15:** 100% Date powder, **L96:** 50% Refined sugar + 50% Date powder, **P73:** 25% Refined Sugar + 75% Date Powder, **T24:** 12.5% Refined sugar + 87.5% Date powder.

Table 5: Texture Profile of Chocolate Samples.

Sample	Stiffness/Hardness (N)	Adhesiveness(g. mm)	Stickiness(g)	Chewiness(N. mm)	Chumminess (g)
S58	265.33±3.05[e]	-123.03±2.64[e]	-57.67±2.08[d]	51.50±3.60[a]	64.67±0.58[a]
D15	467.67±2.08[a]	-84.30±1.05[a]	-44.91±2.00[c]	27.33±0.58[e]	21.10±1.41[d]
L96	327.67±11.84[d]	--108.30±3.05[d]	-51.20±4.05[c]	35.33±4.16[b]	24.33±0.58[b]

P73	356.67±7.09[c]	-101.33±1.53[c]	-49.33±1.15[a]	33.65±1.15[c]	22.40±1.73[c]
T24	376.67±5.86[b]	-92.67±1.53[b]	47.33±1.53[b]	31.67±3.21[d]	21.67±0.58[d]

Values are mean± SD of triplicate; Duncan separation of means with same alphabets are not different ($p<0.05$) in each column. **S58:** 100% Refined sugar, **D15:** 100% Date powder, **L96:** 50% Refined sugar + 50% Date powder, **P73:** 25% Refined Sugar + 75% Date Powder, **T24:** 12.5% Refined sugar + 87.5% Date powder.

Table 6: Sensory Scores of Chocolate Samples

Sample	Colour	Taste	Mouth feel	Aroma	Overall Acceptability
S58	7.47±1.25[a]	6.27±0.88b[c]	6.80±0.94[a]	6.93±1.03[a]	6.93±0.79[a]
D15	7.40±1.12[a]	5.73±2.05[c]	6.13±1.85[a]	6.53±1.81[a]	6.67±1.88[a]

L96	7.87±0.99[a]	7.40±1.06[a]	6.87±1.06[a]	7.20±0.94[a]	7.53±0.74[a]
P73	7.60±0.83[a]	6.47±1.36[abc]	6.53± 1.40[a]	6.87±1.13[a]	6.87±0.74[a]
T24	7.60±0.98[a]	7.13±1.51[ab]	7.07±1.39[a]	7.47±1.25[a]	7.47±0.99[a]

Values are mean± SD of triplicate; Duncan separation of means with same alphabets are not different ($p<0.05$) in each column. **S58:** 100% Refined sugar, **D15:** 100% Date powder, **L96:** 50% Refined sugar + 50% Date powder, **P73:** 25% Refined Sugar + 75% Date Powder, **T24:** 12.5% Refined sugar + 87.5% Date powder.