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# Effect of Adding Matcha Powder (Green Tea) on Improvement Chemical and Sensorial Properties of Pudding

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## ABSTRACT

This study was conducted to study the effect of adding matcha powder on the chemical and sensory properties of prepared pudding. Matcha was added at different concentrations of 3,5 and 10%. Results of the chemical analysis showed that matcha powder contained 3.66% moisture, 39.81% protein and 47.97% carbohydrates. It also had a high content of bioactive compounds namely phenols and flavonoids being 23.83% and 33.8% respectively. Matcha also have the ability to inhibit cancer cells which tested in both of liver and breast cells infected . Results showed that matcha had a strong effect on infected breast cells at a rate of 12.93±0.9 and a moderate effect on infected liver cells at a rate of 31.78±1.8. Results of sensory evaluation of matcha pudding showed that the samples which prepared by adding 3% matcha to pudding have a high values in taste, smell and overall acceptability. Results of chemical analyses also showed that the prepared pudding samples with added 5% matcha contained a high content of protein 19.06% and carbohydrates 11.32%. So this study recommended that adding of matcha at the concentration of 3% and 5% to food products could increase the nutritional value and sensory quality of product. These results are satisfactory for a natural product such as matcha. Therefore, the study recommended adding matcha to food products, especially pudding, to increase their nutritional value and improve sensory characteristics. It is also considered one of the natural means to inhibit cancer cells or reduce the incidence of cancer.

***Keywords*:** Matcha – chemical composition – pudding – anticancer.

## INTRODUCTION

Matcha *(Camellia Sinensis(L.)* is a type of tea which originates from Japan and has many amazing features beneficial to health as it contains a high percentage of polyphenols, amino acid, flavonoids and antioxidant. *Jakubczyk, et al.(2020).*Matcha green tea is obtained from the leaves of green tea plant grown under specific condition using about 90% shade, The tea plants are grown in shade for several weeks before harvest to increase the levels of chlorophyll and amino acids in the leaves. After harvesting, the leaves are processed into a fine powder called matcha. *Sakurai et al.(2020)*. Matcha green tea had gained a lot of attention for its potential health benefits. Studies have indicated that matcha can improve brain function, lower cholesterol, reduce inflammation and even fight cancer. While research is still in its early stages, studies have shown that matcha may be effective against breast cancer cells. *Sokary et al.(2023).*

Matcha green tea polyphenolic compounds are known to act as strong antioxidant, explanation for this effect that polyphenols effectively inhibit proteolytic enzymes like urokinase. Cancer require these enzymes to invade cells and from metastases. *Weiss et al.(2003)*. Matcha green tea *consumption* can help to improve psychopathological symptoms and provide neuroprotection *Fujioka et al. (2016)*.

*Yuksel et al.(2017)* confirmed that adding matcha to ice cream significantly affected the physical and chemical properties and mineral composition, and increasing its concentration led to an increase in the sensory properties of ice cream, as well as the color, protein, and acidity values. Therefore, matcha can be considered a natural substance suitable for ice cream production in terms of nutritional value, physical and chemical properties, and mineral composition.

So this study aimed to prepare a new pudding formula with 3, 5 and 10% of Matcha Green tea that promoted chemical, physical and functional properties .

## MATERIALS AND METHODS

**Materials:**

**Raw Materials:**

Matcha green tea powder *(Camellia Sinensis(L.)* was purchased from Imtenan Company, El-Mansoura city, El Dakahlia Governorate, Egypt.

**Other Ingredients**

Starch, liquid milk, vanilla and sugar were purchased from local market, El-Mansoura city, El Dakahlia Governorate, Egypt.

**Chemicals:**

All Chemicals used were obtained from Al Gomhoria Pharmaceuticals and Chemicals Company. , EL-Mansoura city, El Dakahlia Governorate, Egypt.

**Methods:**

**Technological Methods**

Matcha Green tea powdered were subjected to prepare pudding as follows:

**Preparation of Matcha pudding:-**

Matcha powder was adding as substituted 3 , 5 and 10% instead of starch to prepare Pudding Mixture, pudding was prepared as described by *Sammanian and Razvi (2017)*.

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Sugar dissolved in milk then added to vanilla and dissolved matcha with adequate amount of water droplet. Previous mixture was mixed with milk perfectly using hand b*lender Model (MQ3020WH)* DE. The mixture was placed on the stove until it boiled. After that, starch is added slowly with continuous stirring with a hand mixer for five minutes until the mixture is blended.

Finally The pudding was poured into glass cups, Then stored at refrigerator overnight at 4°C until further analysis were carried out.

**Chemical Analysis of raw materials and Matcha pudding:**

Moisture, ash, fat and crude protein were determined according to the method described by *AOAC (2019.* Total Nitrogen determination was accomplished using the Khildahl method, nitrogen content was multiplied by factor of (6.25)and expressed as crude protein. While Total carbohydrate was calculated by following equation:

**Carbohydrates content by difference = 100 - % (moisture+ ash+ fat+ protein).**

**-Determination of Minerals content of raw materials and Matcha Pudding:**

Iron, calcium, sodium, potassium, magnesium, phosphorus and zinc levels were determined as indicated by *AOAC(2019).*

**-Determination of Bioactive compounds:**

**-Determination of Total Phenolic compounds content (TPC):**

The total phenolic content (TPC) in matcha and pudding were determined using Spectrophotometer (Model T80, UK) with some modification at Seeds and Tissues Pathology Laboratory, Faculty of Agriculture, Mansoura University, Egypt according to the method by Singleton et al.(1965).

**-Determination of total flavonoids content (TFC):**

Total flavonoid compounds content in matcha and Pudding were determined using Spectrophotometer (model T80) *Zhuang et al,. (1992).*

**-Determination of Free Radical scavenging activity (DPPH%):**

DPPH content in matcha and pudding were determined using Spectrophotometer (model T80) according to the method by *Siger et al (2008)* .

**-Determination of Vitamin C:**

Vitamin C content was determined as mentioned by *Sadasivam et al. (1987)* using iodine Titration Method at Seeds and Tissues Pathology Laboratory, Faculty of Agriculture, Mansoura University, Egypt.

**Cytotoxicity Assay of Matcha powder:**

**A. Cell line Assay:**

Hepatocellular carcinoma (HEPG-2) cells and Mammary gland breast cancer (MCF-7). The cell lines were obtained from ATCC (American Type Culture Collection) via Holding company for biological products and vaccines (VACSERA), Cairo, Egypt.

Doxorubicin was used as a standard anticancer drug for comparison.

**B.MTT assay (Master Nano Drug Delivery system):**

The cell lines mentioned above were used to determine the inhibitory effects of compounds on cell growth using the MTT assay. This colorimetric assay is based on the conversion of the yellow tetrazolium bromide (MTT) to a purple formazan derivative by mitochondrial succinate dehydrogenase in viable cells. Cell lines were cultured in RPMI-1640 medium with 10% fetal bovine serum. Antibiotics added were 100 units/ml penicillin and 100µg/ml streptomycin at 37 °C in a 5% Co2 incubator. The cell lines were seeds in a 96-well plate at a density of 1.0x104 cells/well. At 37 °C for 48 h under 5% Co2. After incubation the cells were treated with different concentration of compounds and incubated for 24 h. After 24 h of drug treatment, 20 µl of MTT solution at 5mg/ml was added and incubated for 4 h. Dimethyl sulfoxide (DMSO) in volume of 100 µl is added into each well to dissolve the purple formazan formed. The colorimetric assay is measured and recorded at absorbance of 570 nm using a plate reader (EXL 800 , USA). The relative cell viability in percentage was calculated as (A570 of treated samples/A570 of untreated sample) X 100. (Mosmann et al. (1983).

**Sensory Evaluation of Matcha pudding samples :**

Prepared Pudding samples were placed in the refrigerator at 4°C until sensory evaluation. Were carried out according to *AACC(2005),* by twenty post-graduate students from the Food Industries Department at the Faculty of Agriculture, Mansoura University. . The quality score of pudding including color (10), taste (10), odor (15), texture (15), overall acceptability (50).

**Statistical analysis:**

The data obtained were statistically analyzed by ANOVA with product statistical package for the social sciences (SPSS) version 17 (2008) according to *Gomez and Gomez, (1984).*

## RESULTS AND DISCUSSION

**Chemical composition of matcha powder:**

The chemical composition of matcha powder were presented in Table (1) Results showed that moisture content was 3.66%, protein content was 39.81%, while ash percentage reached to 5.33%, fat was 3.23% and total carbohydrates content was 47.97%. Our obtained results were in accordance with *Juneja et al.,(1997)* who found that moisture content 4.8%, protein 30.7%, Ash 7.4 and lipid content 5.3%.These results were slightly close to those obtained by *(Kolackova et al. 2020*) They found that matcha powder contain Ash content (5.2-8.7%) and protein (20.3-35.0%) and *( Ebrahimi et al. 2022*) who found that the ash content (6.13%).

**Table 1. Chemical composition and Minerals content of Matcha green tea powder:**

| Component | Matcha green tea powder |
|---|---|
| Moisture% | 3.66 |
| Protein% | 39.81 |
| Ash% | 5.33 |
| Fat% | 3.23 |
| Carbohydrates % | 47.97 |
| Fe (ppm) | 256.6 |
| Ca (ppm) | 1443.6 |
| Mg (ppm) | 2362 |
| Zn (ppm) | 67.89 |
| Na (ppm) | 172.64 |

Minerals content of matcha powder were presented in Table (1) obtained results showed that there were some Macro elements detected namely, Iron (Fe) content reaches to 256.6 ppm, Calcium(Ca) content was 1443.6 ppm, While the magnesium (Mg) content of the raw material reaches

2362 ppm, While zinc (Zn) content registered 67.89 ppm. Finally, sodium (Na) content was 172.64 ppm.

This results were in matching with those of *Juneja et al.(1997)* who studied that Fe content from 100 to 200ppm and *Koch et al. (2018)* detected that Fe 252 ± 18.9 ppm and Ca 1636 ± 90.3ppm. *Kolackova et al.(2021)* who reported that Mg content in matcha green tea 2340 ± 45ppm. *Kolackova, et al. (2020)* who said that Zn content in matcha 68.5 ± 1.5 ppm and Na 124–185ppm.

Results in Table (2) showed that different bioactive compounds of Matcha green tea Vitamin C (43.24mg/100g), While total phenolic content(23.83mg/g), total flavonoids content (33.8 mg/g) and antioxidant activity DPPH% (55.04%). All above results are found to be slightly near with those obtained by *Jakubczyk et al.(2020)* who reported that matcha contained vitamin C (44.8 mg/100g) and 41.2% DPPH. *Zhou et al.(2021)* who found that matcha green tea had 19.84±0.67 mg/g polyphenols. *Sayuti et al.(2021)* who detected that Total flavonoids of matcha green tea was 29.21±0.38 mg RE/g.

**Table 2. Bioactive compounds and antioxidant activity (DPPH)% of Matcha green tea :**

| Sample | Vitamin C (mg/ 100gsample) | Total phenolic content (mg/g) as galic acid | Total flavonoids content (mg/g) RE | Antioxidant activity DPPH % |
|---|---|---|---|---|
| Matcha green tea | 43.24 | 23.83 | 33.8 | 55.04 |

Results in Table (3) showed that all concentrations of matcha that were able to reduce the viability of liver and breast cancer cells. It was found that a concentration of 4.50±0.2 of DOX had a very strong effect on liver cancer cells, while a concentration of 31.78±1.8 of matcha had a moderate effect. A concentration of 4.17±0.2 of DOX had a very strong effect on breast cancer cells, while a concentration of 12.93±0.9 of matcha had a strong effect. This result were matching with *(Bonuccelli et a..2018)* It has been proven that matcha has antioxidant and anti-breast cancer cell effects, which reduces the risk of breast cancer in women by inhibiting the infiltration of tumor-associated macrophages and the secretion of IL-6 and TNF-α, They are cytokine proteins that play a major role in the body's immune and inflammatory responses and are essential for innate immunity and defense against infection. . It has also been proven that treatment with matcha hinders the formation of cancer cells by 50% and stops their spread.

**Table 3. Cytotoxic activity of matcha green tea powder against human cell line(liver and breast):**

| Component. | In vitro Cytotoxicity $IC_{50}$ (µg/ml)* | |
|---|---|---|
| | HePG-2 | MCF-7 |
| DOX | 4.50±0.2 | 4.17±0.2 |
| Matcha green tea | 31.78±1.8 | 12.93±0.9 |

**$IC_{50}$: Concentration able to decrease cell viability by 50% versus control cultures.HepG-2: Hepatocellular carcinoma cell line.MCF7: Breast carcinoma cell line $IC_{50}$ (µg/ml) : 1 – 10 (very strong). 11 – 20 (strong). 21 – 50 (moderate). 51 – 100 (weak) and above 100 (non-cytotoxic) DOX : Doxorubicin drug**

Sensory testing plays an important role in evaluating food quality because it measures consumer preferences. *(Bryhni et al. 2002)* .

The sensory properties of prepared pudding with different percentage of matcha green tea powder were evaluated to choose the best addition ratio to produce high quality pudding acceptable to consumer. Samples of pudding were evaluated in terms of their internal and external properties as shown in table (4) and the results showed a difference ($p \leq 0.05$) in color degrees between the mixtures. As P1 was more acceptable in taste than the rest of the samples. There was a significant difference between Pc and p 3, which contained 10% matcha. In terms of acceptability there were numerical comments between Pc and sample which containing 3% matcha, samples containing 5% and 10%.

**Table 4. Sensory evaluation of studied matcha pudding samples:**

| Properties Pudding samples | Color(10) | Taste(10) | Odor(15) | Texture(15) | Overall Accept-ability(50) | Total(100) |
|---|---|---|---|---|---|---|
| Pc | $9.91^{a} \pm 0.26$ | $9.79^{a} \pm 0.40$ | $15.00^{a} \pm 0.00$ | $14.94^{a} \pm 0.24$ | $49.52^{a} \pm 1.28$ | $99.23^{a} \pm 1.71$ |
| P1 | $9.82^{a} \pm 0.35$ | $9.94^{a} \pm 0.17$ | $14.50^{ab} \pm 1.27$ | $14.26^{ab} \pm 1.75$ | $49.17^{a} \pm 2.43$ | $97.58^{a} \pm 4.41$ |
| P2 | $9.58^{b} \pm 0.71$ | $9.58^{a} \pm 0.71$ | $14.64^{ab} \pm 0.70$ | $14.23^{b} \pm 1.82$ | $48.70^{abb} \pm 3.65$ | $96.64^{ab} \pm 6.37$ |
| P3 | $9.67^{ab} \pm 0.68$ | $9.14^{b} \pm 1.06$ | $14.17^{b} \pm 1.47$ | $14.05^{b} \pm 2.08$ | $47.82^{b} \pm 5.29$ | $94.70^{b} \pm 9.84$ |
| LSD (at5%) | *0.31 | **0.53 | *0.80 | *0.87 | *1.66 | *3.93 |

**Pc control, P1 pudding with 3% matcha, P2 pudding with 5% matcha and P3 pudding with 10% matcha.**

Overall, the table suggests that consumers prefer pudding with a lower proportion of matcha. P 3 was not accepted by sensory evaluators. This could be due to the bitterness of matcha, or simply a preference for the taste of the control pudding. *Eka et al.(2024)* found that matcha has bitter aftertaste, which discourages people from consuming it. Based on a survey, 47.8% of people dislike it, while 28.8% prefer it. This percentage is mostly among people aged 10 to 19 years. Therefore, I suggest inventing a method of adding chocolate pudding to the top layer of matcha pudding to increase consumers' acceptance of it from a sensory perspective.

**Chemical composition of studied matcha pudding samples:**

Results in Table (5) showed that the chemical composition of matcha pudding were also followed control pudding sample (Pc) have the highest value of moisture content with 68.84% and the values decreases with the increasing amount of matcha added. Pudding sample P3, which contained (10%) matcha, has the lowest moisture content 63.24%.

Also, results obtained that protein content have the same trend as moisture content. The control sample (Pc) have the highest protein content 17.06%, while (P3) has the lowest value which was 12.19%.

Also, Ash content refers to the amount of inorganic residue left after burning a sample. The ash content varied slightly among all samples, with a range of 0.59% to 0.78%. Fat content were recorded 7.2% at Pc while recorded 5.1% at P2 which was lowest amount . Finally, carbohydrates content was 6.118% at Pc which was lowest amount but the highest percentage was 16.77% in (P3).

Overall, Results also showed that the addition of matcha powder to pudding sample decreases the moisture and increases protein content, while the ash content remains relatively unchanged. All above results are found to be

slightly near to date obtained by *Damian et al.(2017)* who stated that chemical composition of the commercial pudding has 59.0% water, 10.0% protein and fat 7.2%.*Suzauddula et al.(2020)* which reported that Dairy Milk pudding had 74.98% moisture, 4.98% protein and 1.29% Ash.

**Table 5. Chemical composition of prepared matcha pudding samples**

| | Chemical composition % | | | | |
|---|---|---|---|---|---|
| **Pudding Samples** | **Moisture** | **Protein** | **Ash** | **Fat** | **Carbohydrates** |
| Pc | 68.84 | 17.0625 | 0.78 | 7.2 | 6.118 |
| P1 | 64.00 | 18.8125 | 0.66 | 6.3 | 10.2275 |
| P2 | 61.83 | 19.0625 | 0.59 | 5.1 | 13.4175 |
| P3 | 60.24 | 20.1875 | 0.60 | 5.8 | 18.1725 |

**Minerals content of studied matcha pudding samples:**

Results at Table(6) showed minerals content of matcha pudding samples. The table lists four samples labeled P0, P1, P2, and P3. It appears that these samples are matcha pudding with varied levels of matcha added. Pc seems to be the control sample with no matcha added. P1, P2, and P3 have 3%, 5%, and 10% matcha added respectively.

It also shows the potassium (K), phosphorus(P), sodium (Na) and calcium (Ca) content of matcha pudding present in each sample .

It is clear from obtained results that the control pudding sample contained the lowest amount of K (535.37) ppm, while it contains the highest amount of Ca (7877.81) ppm and Na (283.37)ppm. But P registered (378.32)ppm. Also, pudding sample P1 which containing 3% matcha represented the highest percentage of K( 758.47 )ppm and P (534.74)ppm, But Na was (281.55)ppm and Ca 7217.39)ppm. ( Data revealed also that pudding sample (P2) contained 5% matcha has the lowest amount of (P) (344.42ppm) while the percentage of Na recorded 234.69ppm, Ca 5733.26ppm and K recorded (594.86ppm). Results also obtained that, K in sample p3 which containing 10% matcha have a highest amount of K.

All above results are found to be according with *Hendek Ertop et al. (2019)* who wrote that milk pudding contains Na 245.80ppm , K 1819.5 ppm, Ca 1306.2ppm and P1171.90ppm.

**Table 6. Minerals content of matcha pudding:**

| | Minerals content ( ppm) | | | |
|---|---|---|---|---|
| **Pudding Samples** | **K** | **P** | **Na** | **Ca** |
| P c | 535.37 | 378.32 | 283.37 | 7877.81 |
| P 1 | 758.47 | 534.74 | 281.55 | 7217.39 |
| P 2 | 594.86 | 344.42 | 234.69 | 5733.26 |
| P 3 | 747.18 | 401.33 | 216.44 | 6013.39 |

**Bioactive compounds and antioxidant activity (DPPH) of matcha pudding samples:**

Results of total phenolic content, flavonoid content, Total antioxidant activity (DPPH) and ascorbic acid concentration (vitamin C) content in all prepared pudding samples with and without matcha powder in different concentration were tabulated in Table (7).

From obtained results, it could be noted that control pudding sample has the lowest total phenolic compounds content (2.02 mg/g) and total antioxidant activity (16.43%), While Total flavonoids (30.13mg/g) and Ascorbic acid (10.81mg/100g). The highest total flavonoids content (41.73mg/g) was found in pudding sample p(1) which contained 3% matcha.

From the same Table, it could be concluded that pudding sample with 5% matcha represented a moderate increase in phenols compound content (6.28mg/g) and the lowest percentage in flavonoids content (19.33mg/g), while it represents the highest percentage in antioxidant activity DPPH% (77.65%) and ascorbic acid recorded (8.18mg/100g). The pudding sample with 10% matcha has the highest total phenolic content (10.08 mg/g), while it recorded the lowest value of vitamin C (5.45mg/100g) and DPPH% (37.61%).

Overall, Results in this table showed that adding of matcha to pudding sample rised the total amount of phenolic and flavonoids compounds. Table also showed that the overall antioxidant activity of the pudding increases with the amount of matcha added expect sample contained 10% matcha (p3). The obtained results are in nearly agreement with *Yazıcıoglu et al,.(2023)* who reported that control pudding sample contained 2.47±0.60 total phenolic content, 0.20±0.001 total flavonoid content and antioxidant activity 21.35±1.56.

**Table 7. Bioactive compounds, vitamin C and antioxidant activity (DPPH) of matcha pudding:**

| **Pudding samples** | **Total phenolic content (mg/g)** | **Total flavonoids content (mg/g)** | **Vitamin C (Conc. mg/100g)** | **Antioxidant activity (DPPH %)** |
|---|---|---|---|---|
| P(c) | 2.02 | 30.13 | 10.81 | 16.43 |
| P(1) | 5.23 | 41.73 | 10.81 | 73.79 |
| P(2) | 6.28 | 19.33 | 8.18 | 77.65 |
| P(3) | 10.08 | 29.73 | 5.45 | 37.61 |

## CONCLUSION

So, this paper recommended that matcha green tea powder could be added for increasing the amount of protein, bioactive compounds and antioxidant activity in some food products such as pudding.

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# تأثير إضافة الماتشا على تحسين الصفات الكيميائية والحسية للبودنج

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## الملخص

تم اجراء هذا البحث لدراسة مدى تأثير إضافة مسحوق الماتشا على الصفات الكيميائية والحسية للبودنج حيث تمت إضافة مسحوق الماتشا بتركيزات ٣, ٥ و١٠٪ وأظهرت نتائج الاختبارات الكيمائية احتواء مسحوق الماتشا على نسبة ٣,٦٦٪ من الرطوبة و ٣٩,٨١ من البروتين و ٤٧,٩٧٪ من الكربوهيدرات وأيضا ارتفاع محتواها من المركبات الحيوية الفعالة كالفينولات والفلافونيدات وكانت ٢٣,٨٣٪ و ٣٣,٨٪ على التوالى و تحتوى على ٤٣,٢٤ ملجم/١٠٠جم من فيتامين سى و ٥٥,٠٤٪ من مضادات الأكسدة.. كما تم اختبار قدرة الماتشا على تثبيط الخلايا السرطانية على الانتشار فى كلا من خلايا الكبد وخلايا الثدى المصابة بالسرطان وأظهرت النتائج أن الماتشا ذات تأثير قوى على نشاط الخلايا السرطانية فى الثدى بنسبة إضافة ١٢,٩٣ ± ٠,٩ وتأثير معتدل على خلايا الكبد ٣١,٧٨ ±١,٨.كما أظهرت نتائج التقييم الحسى لعينات لبودنج الماتشا أن العينات المحضرة بإضافة نسبة٣٪ ماتشا للبودنج أعطت قيما مرتفعة فى صفات الطعم والرائحة والقبول الكلى .وأيضا أظهرت نتائج الاختبارات الكيميائية ان العينة المحضرة من البودنج بإضافة ٥٪ من الماتشا ارتفعت محتواها فى البروتين ١٩,٠٦٪ و الكربوهيدرات ١١,٣٢٪ وتعد هذه النتائج مقبولة بالنسبة لمنتج غذائى طبيعى لا يحتوى على أى مواد صناعية، لذا توصى الدراسة بإضافة مسحوق الماتشا إلى عينات المواد الغذائية وخاصة البودنج لرفع قيمتها الغذائية وتحسين الصفات الحسية كما انها تعد أحد الوسائل الطبيعية للحد من انتشار الخلايا السرطانية أو تقليل الاصابة بالسرطانات.