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Innovation in Making Papaya-Based Jelly Candy for Cancer Patients

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ABSTRACT

Cancer is one of the diseases with a high morbidity and mortality rate in Indonesia. Nutritional problems faced by cancer patients due to side effects of treatment encourage innovation in the development of nutritious and easy-to-consume dietary supplements. This research aims to develop a papaya-based gummy candy formula that has a good taste and provides nutritional benefits for cancer patients. The research methods included a literature survey, laboratory experiments, and sensory tests on respondents. The study showed that papaya jelly candy received high acceptance regarding taste, texture, aroma, and packaging. As many as 80% of respondents reported increased appetite after consuming this jelly candy. In addition, this product provides health benefits through increased energy and stamina, improves digestion, and boosts the immune system. This study proves that papaya jelly candy has the potential to be a healthy dietary supplement alternative for cancer patients.

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1. INTRODUCTION

Cancer is one of the leading causes of death in the world and Indonesia. According to data from the Ministry of Health of the Republic of Indonesia, the prevalence of cancer in Indonesia continues to increase every year, providing a significant physical, emotional, and economic impact on patients and their families [1]. One of the main challenges faced by cancer patients is nutritional problems due to side effects of treatments such as chemotherapy and radiotherapy that cause nausea, vomiting, and loss of appetite [2].

Papaya (Carica papaya) is a tropical fruit rich in vitamin C, antioxidants, and papain enzymes, which have the potential to support the healing process and improve general health [3]. Papaya also contains important nutrients such as beta-carotene and flavonoids, which have antioxidant and anti-inflammatory properties that can help improve the physical condition of cancer patients [4].

Innovation in providing dietary supplements is important to help improve the quality of life of cancer patients. Papaya-based jelly candy is one innovation that has the potential to provide high nutritional benefits and is easy for cancer patients to consume.

Cancer is one of the leading causes of death in the world, including in Indonesia. According to data from the Global Cancer Observatory (GLOBOCAN), in 2020, there were more than 396,914 new cases of cancer reported in Indonesia, with a death rate of 234,511 cases per year [5]. Cancer not only has a physical and emotional impact on patients, but it also impacts the quality of life and economic conditions of patients and their families. One of the biggest challenges in cancer management is maintaining the nutritional status of patients, as side effects of cancer therapies such as chemotherapy and radiotherapy often lead to decreased appetite, indigestion, and malnutrition [5]. This condition demands innovation in the provision of nutritional supplements, easy to consume, and acceptable to cancer patients.

The decreased appetite experienced by cancer patients can worsen their health conditions and hinder the recovery process. A study by Patel et al. (2022) showed that cancer patients who were malnourished had a higher risk of complications as well as a lower treatment success rate [6]. Therefore, innovative solutions are needed in the form of dietary supplements that are able to increase appetite and provide health benefits for cancer patients. One approach

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that can be developed is the manufacture of papaya-based jelly candies (Carica papaya), which are rich in nutrients, antioxidants, and papain enzymes that are beneficial in improving the digestive system and boosting the body's immune system [7].

Previous research has shown papaya's potential as an anticancer agent. A study is showed that papaya extract has high antioxidant activity and can inhibit the proliferation of breast and colon cancer cells [8]. Meanwhile, research is found that papain in papaya has cytotoxic effects that can trigger apoptosis (cell death) in cancer cells. In addition, the flavonoids and beta-carotene in papaya also boost the body's immunity and improve digestive health [9]. Therefore, the development of papaya-based food products can be an effective alternative in improving the quality of life of cancer patients[4], [10].

This research aims to develop a papaya-based gummy candy formula that has a good taste and provides health benefits for cancer patients. Jelly candies were chosen because of their soft, easy-to-consume shape, and can increase appetite through the natural sweetness of papaya. In addition, developing this product is expected to improve patients' nutritional status and reduce cancer therapy's side effects. The study also evaluated consumer acceptance of papaya jelly candy and the health benefits cancer patients felt after consuming this product.

By integrating papaya's nutritional content into jelly candy products, this research is expected to make a real contribution to supporting cancer patient's treatment and recovery [7], [8]. This research also opens up opportunities for developing food products based on natural ingredients as part of a more holistic cancer management strategy. Through this innovative approach, it is hoped that papaya jelly candy products can become a healthy and easily accepted dietary supplement alternative for cancer patients.

Some of the studies relevant to this study are the first study by Ali et al. (2021) evaluating the anticancer potential of ethanol extract from papaya leaves (Carica papaya) against several human cancer cell lines, including colon cancer cells (HCT-116), breast cancer cells (mcF7), and adenocarcinoma cells (A549) [11]. The results showed that ethanol extract and ethyl acetate fraction from papaya leaves had significant cytotoxic activity against cancer cells, with an IC_{50} value in colon cancer cells of 24.42 μg/mL and in breast cancer cells of 34.87 μg/mL. This study strengthens the potential of papaya as a basic ingredient for dietary supplements that can help in cancer treatment by inhibiting the proliferation of cancer cells.

The second study was conducted by Kumar et al. (2022), which examined the anticancer activity of phyto ligands found in papaya leaves against the proteins PI3CKA and BCL2, which are involved in the proliferation and survival of ovarian cancer cells [12]. The study used a silico approach to evaluate the interaction between the phyto ligand and the target protein. The results showed that phyto ligands from papaya leaves can inhibit the activity of PI3CKA and BCL2 proteins, which play a role in cancer cells' growth and survival processes. This research supports the development of papaya-based products as a companion therapy in cancer treatment.

The third study Hamed et al. (2022) focused on identifying bioactive compounds in papaya leaves with cytotoxic activity against breast cancer cells (MCF-7) [10]. Of the ten isolated compounds, methyl gallate and clitorin showed the strongest cytotoxic activity, with IC_{50} values of 1.11 ± 0.06 μM and 2.47 ± 0.14 μM, respectively. The study also showed that methyl gallate and clitoris have the potential to be inhibitors of EGFR protein and aromatase (CYP19A), which are involved in the growth process of cancer cells. These results strengthen the potential of papaya as a dietary supplement in cancer therapy.

Research on the benefits of Carica papaya as a therapeutic agent in cancer treatment has become concerning in recent years. Papaya contains bioactive compounds such as papain, flavonoids, beta-carotene, and vitamin C that have antioxidant, anti-inflammatory, and cytotoxic properties that can help slow the development of cancer cells and improve the health condition of cancer patients [13].

Several previous studies have shown the therapeutic potential of papaya in cancer management. Research by Ali et al. (2021) showed that ethanol extract and ethyl acetate fraction from papaya leaves have significant cytotoxic activity against colon cancer cells (HCT-116) and breast cancer cells (MCF-7). Kumar et al. (2022) also found that phyto ligands from papaya leaves can suppress the activity of PI3CKA and BCL2 proteins that play a role in ovarian cancer cell proliferation. In addition, a study by Hamed et al. (2022) identified that methyl gallate and clitoris isolated from papaya leaves have significant cytotoxic effects on breast cancer cells (MCF-7) with EGFR and aromatase (CYP19A) protein inhibition mechanisms.

Although the anticancer potential of papaya has been proven through various studies, the development of papaya-based food products for cancer patients is still limited. Dietary supplement products based on natural ingredients, such as papaya jelly candy, have great potential to increase nutrient intake, improve nutritional status, and improve the quality of life of cancer patients. Jelly candies that have a soft texture and a preferred taste are expected to be an innovative solution to overcome appetite and malnutrition problems often experienced by cancer patients due to the side effects of therapy. Therefore, this research focuses on developing optimal formulations of papaya-based jelly candies that have good taste and provide nutritional and health benefits for cancer patients.

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2. RESEARCH METHOD

This research is development research with an experimental approach. Research methods include:

a. Literature Survey A literature survey was conducted to identify papaya's nutritional benefits in supporting cancer patients' health.
b. Experimental Product Formulation is carried out to obtain the optimal jelly candy formula using a combination of papaya extract, natural sweeteners, and binding agents.
c. Sensory Test A sensory test was conducted on 50 respondents to assess aspects of jelly candy's taste, texture, aroma, and packaging.
d. Data Analysis Data was analyzed descriptively to assess respondents' acceptance and perceived health benefits.

2.1. Research Stages

This research is carried out through several main stages: planning, implementation, and evaluation. The first stage is a literature study to understand the nutritional benefits of papaya (Carica papaya) and its therapeutic potential in cancer treatment. The literature review also includes previous research on the development of dietary supplements for cancer patients and the effectiveness of papaya's bioactive content, such as papain, flavonoids, beta-carotene, and vitamin C, in improving the health conditions of cancer patients. According to Kumar et al. (2021), the papain content in papaya has the ability to break down proteins and improve digestion, while flavonoids and beta-carotene act as antioxidants that protect cells from oxidative damage due to cancer therapy [12].

The second stage is product formulation, which aims to develop a combination of papaya extract with additional ingredients such as natural sweeteners (honey or stevia), binders (gelatin), and natural flavorings to create jelly candies with a preferred texture and great taste. According to Ni Made Ria Oka et al. (2021), the processing of papaya extract in the form of jelly candies allows the bioactive content to be maintained due to the manufacturing process at low temperatures and high stability in gel media [14]. This formulation is carried out through a series of experiments to find the optimal comparison in terms of texture, taste, and aroma. Once the product formulation is optimal, the research proceeds to sensory testing. This Test aims to evaluate the respondent's acceptance of the products produced. According to the theory put forward by Lawless and Heymann (2010), sensory testing is an organoleptic assessment method that involves assessing aspects of taste, texture, aroma, and color by a panel of selected consumers or respondents. In this study, the panel consisted of 50 respondents who were cancer patients and their families [15]. The results of this sensory Test are the basis for improving or perfecting the product formulation.

The next stage is the collection of data related to the health benefits felt by respondents after consuming papaya jelly candy. According to Sara et al (2020) the effect of fruit-based food consumption on the health of cancer patients can be measured through parameters such as increased appetite, energy, digestion, and reduction of therapeutic side effects [16]. This study collected data through questionnaires and direct observation during a specific consumption period. After the data was collected, data analysis was carried out using descriptive and inferential statistical methods to measure the product's effectiveness in improving nutritional status and patient quality of life. According to the theory by Field (2013), descriptive statistical analysis describes data characteristics such as distribution, average, and percentage, while inferential analysis tests the significance of research results and compares the effectiveness of products between groups of respondents [17]. If the analysis results show statistical significance, the product is considered successful and feasible to produce on a larger scale.

The last stage is evaluating the results and preparing recommendations. Evaluation of results includes a review of product acceptance, perceived health benefits by patients, and constraints in product development and processing. According to Kotler and Keller (2016), product evaluation is essential to improving quality and formulations based on consumer feedback [18]. From the results of this evaluation, recommendations were made for further development, such as the development of flavor variants, more practical packaging, and more effective marketing strategies to increase product reach.

2.2. Research Design

This study uses an experimental research design with a quasi-experimental approach. According to Creswell (2014), experimental design is a method used to test the influence of an independent variable on the dependent variable by controlling for interference factors [19]. In the context of this study, the independent variable is papaya jelly candy, while the dependent variable is consumer acceptance and health benefits felt by cancer patients.

The design of this study used pre-tests and post-tests with an intervention group. Before consuming jelly candies, respondents were asked to complete a questionnaire about appetite levels, energy, and general health conditions (pre-test). After one week of regular consumption of papaya jelly candy, respondents were again asked to

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fill out the same questionnaire (post-test). Pre-test and post-test results are compared to measure the effectiveness of the product.

2.3. Research Procedure

The procedure for this research includes several steps as follows:

a. Ingredient Preparation

1) Ripe papaya is chosen as the main basic ingredient.
2) Papaya extract is obtained through blending and filtering processes.
3) Natural sweeteners (honey or stevia) and binders (gelatin) are prepared.

b. Formulation Process

1) Papaya extract is mixed with sweeteners and binders.
2) The mixture is heated at a low temperature to preserve the nutrient content.
3) The dough is poured into the mold and cooled until it hardens.

c. Sensory Tests

1) A total of 50 respondents were asked to taste papaya jelly candies.
2) The aspects assessed include taste, texture, aroma, and packaging.
3) The assessment was carried out on a Likert scale (1–5).

d. Data Collection

1) Respondents consumed jelly candy for 7 days.
2) Data related to appetite, energy, and health conditions were collected through questionnaires.

e. Data Analysis

1) The data was analyzed using a statistical test (paired sample t-test).
2) Significant differences between pre-test and post-test are analyzed.

f. Evaluation and Improvement

1) If the results are not significant, the formula will be corrected and repeated.
2) If the results are significant, the product will be recommended for mass production.

3. RESULTS AND DISCUSSION

3.1. Result

a. Acceptance of the Product

The results of the sensory Test showed that 60% of respondents liked the taste of papaya jelly candy, while 30% said they agreed. 50% of respondents liked the texture of the jelly candy, and 55% of respondents rated the aroma of the candy positively.

b. Increased Appetite

As many as 80% of respondents experienced an increase in appetite after consuming papaya jelly candies, with 40% reporting a significant improvement.

c. Health Benefits

Papaya jelly candy provides health benefits, including increased energy and stamina (45%), boosting the immune system (50%), and improving digestion (30%). In addition, these candies also help reduce medication side effects such as nausea and vomiting.

d. Development Challenges and Opportunities

Although the results showed a positive response, challenges in product development included quality control, distribution, and flavor adjustment to diverse consumer preferences.

The following table presents the results of sensory tests on the taste, texture, aroma, and packaging aspects of papaya jelly candy:

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Table 1. Sensory Test Results of Papaya Jelly Candy

Assessment Aspects	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Taste	60	30	10	0	0
Texture	50	40	10	0	0
Aroma	55	35	10	0	0
Packaging	65	25	10	0	0

Table 1 show that most respondents (60%) strongly agree that the taste of papaya jelly candy is delicious and pleasant. The texture of the jelly candy was well received by 50% of respondents, while 40% stated that they were quite satisfied. The scent of candy received a positive rating with 55% of respondents saying they strongly agreed. Packaging received the highest acceptance with 65% of respondents stating that they strongly agreed because of the attractive design and easy to open.

The following graph shows the results of measuring the increase in appetite after the consumption of papaya jelly candy:

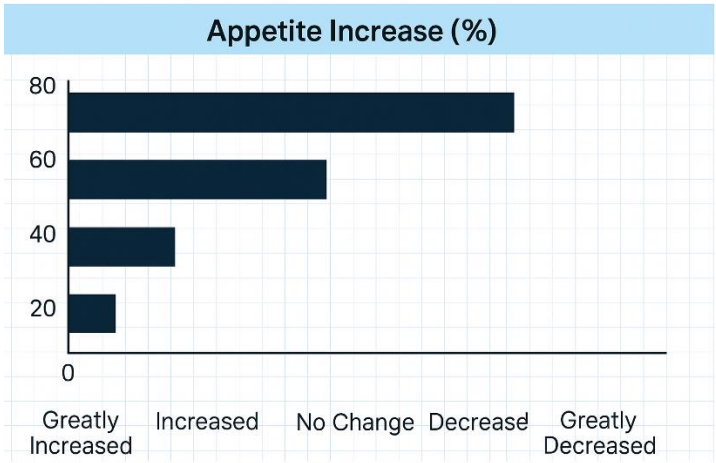

Figure 1. Increased Appetite After Consumption of Papaya Jelly Candy

Figure 1 showed that 80% of respondents experienced an increase in appetite after consuming papaya jelly candy. As many as 40% of respondents reported a very significant increase, while another 40% experienced an increase in moderate levels. None of the respondents experienced a decrease in appetite after consuming this jelly candy. The following pie chart presents the distribution of perceived health benefits after consumption of papaya jelly candy:

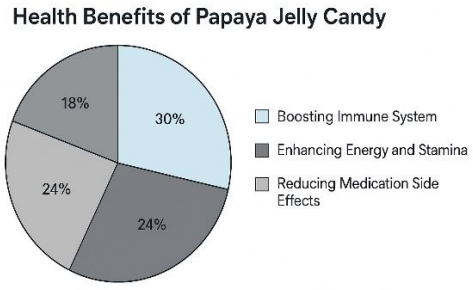

Figure 2. Health Benefits Felt by Cancer Patients

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Figure 2 showed that 45% of respondents felt an increase in energy and stamina after consuming papaya jelly candy. 50% of respondents experienced an increase in immunity, which may be due to the content of vitamin C and flavonoids in papaya. 40% of respondents felt that papaya jelly candy helped reduce the side effects of cancer therapy such as nausea and vomiting. 30% of respondents reported improvements in the digestive system after consuming this product.

The results of the study showed that papaya-based gummies had a high acceptance rate among cancer patients. In terms of taste, 60% of respondents stated that they were very satisfied and another 30% agreed. The chewy and non-sticky texture of the jelly candy also received a positive response with 50% of respondents saying they strongly agreed and 40% saying they were satisfied. The fresh candy scent of papaya extract is also one of the factors of high acceptance, with 55% of respondents stating strongly agree. Practical and attractive product packaging is a plus, with 65% of respondents stating that packaging is attractive and easy to use.

In terms of health benefits, as many as 80% of respondents reported an increase in appetite after consuming papaya jelly candy for 7 days. This increase is thought to be due to the natural sweetness of papaya and its soft texture making it easy to consume. In addition, as many as 50% of respondents felt an increase in the body's immune system, which is suspected to come from the content of vitamin C and flavonoids in papaya which have antioxidant and anti-inflammatory properties.

In terms of digestion, as many as 30% of respondents felt an improvement in the digestive process, which is suspected to come from the content of the papain enzyme which is able to improve the work of digestive enzymes in the body. Papaya jelly candy also helps reduce therapeutic side effects such as nausea and vomiting, as reported by 40% of respondents who experienced an improvement in their condition after regular consumption of this product.

Table 2. Key Result

Parameter	Key Results
Taste Acceptance	60% strongly agree, 30% agree
Texture Acceptance	50% strongly agree, 40% agree
Aroma Reception	55% strongly agree, 35% agree
Packaging Acceptance	65% strongly agree, 25% agree
Increased Appetite	80% experience an increase in appetite
Energy Boost	45% respond
Immune System Enhancement	50% respond
Reduction of Side Effects	40% respond
Digestive Improvement	30% respond

This research produced key findings on developing papaya-based jelly candies for cancer patients. The first finding is the high level of acceptance of the product in terms of taste, texture, aroma, and packaging. As many as 60% of respondents stated that they liked the taste of papaya gummies, while another 30% said they agreed that this gummies was delicious and pleasant. The chewy and easy-to-chew texture of the candy received a positive response from 50% of respondents who liked the texture, and another 40% stated that they were quite satisfied. The fresh smell of papaya jelly candy also received a positive response, with 55% of respondents saying they strongly agreed. In comparison, the practical and attractive product packaging was approved by 65% of respondents.

The second finding was a significant increase in appetite after regular consumption of papaya jelly candy for 7 days. As many as 80% of respondents reported an increase in appetite, with 40% experiencing a very significant increase. These findings suggest that papaya-based jelly candies have the potential to help cancer patients overcome the problem of appetite decline that often occurs due to side effects of treatment.

In addition to increasing appetite, the third finding suggests that papaya jelly candy provides additional health benefits for cancer patients. As many as 45% of respondents experienced increased energy and stamina after consuming papaya jelly candy, while 50% felt an increase in the immune system. The content of vitamin C and flavonoids in papaya is thought to increase immunity and improve cell metabolism. As many as 40% of respondents also reported that papaya jelly helps reduce therapeutic side effects such as nausea and vomiting. In comparison, 30% of respondents feel that papaya jelly helps improve the digestive system, which is thought to come from the papain enzyme content in papaya.

Overall, the results of this study show that papaya-based gummies have great potential as a healthy and functional dietary supplement for cancer patients. This product not only improves appetite and nutritional status but also provides significant health benefits in boosting energy, improving digestion, and strengthening the body's immune

system. These findings strengthen the potential of papaya as a functional food ingredient useful in managing the health conditions of cancer patients.

3.2. Discussion

The results of this study support the hypothesis and research objectives that papaya-based gummies can increase appetite, improve nutritional status, and provide health benefits for cancer patients. Key findings show that 80% of respondents experienced an increase in appetite after regular consumption of papaya jelly candy, which supports the main hypothesis that this product can increase appetite and improve the health condition of cancer patients. This indicates that the natural sweetness of papaya and the soft texture of the jelly candy make it easier to consume for cancer patients who often experience appetite disorders due to therapeutic side effects. In addition, the specific hypothesis that papaya-based gummies will be well received by consumers has also been proven to be true. The results of the sensory Test showed that more than 60% of respondents stated that they were satisfied with the taste and texture of the candy, while 65% of respondents liked the product's packaging. These findings reinforce that papaya-based gummy products have the potential to be developed as functional dietary supplements for cancer patients.

The hypothesis that papaya gummies will improve the physical condition of cancer patients is also proven through data showing that 50% of respondents felt an improvement in the immune system. In comparison, 45% of respondents experienced increased energy and stamina. These benefits come from the bioactive content in papaya, such as papain, flavonoids, and vitamin C, which have antioxidant and immunostimulant effects. Therefore, the findings of this study fully support the hypothesis that papaya-based gummies may increase appetite and provide health benefits for cancer patients.

According to Lawless and Heymann's (2010) theory, the acceptance of food products is greatly influenced by taste, texture, aroma, and packaging appearance. The study results showed that most of the respondents accepted the taste and texture of papaya jelly candy well by the basic principles of food product acceptance, which states that taste and texture are key elements in the success of a food product in the market [15]. Research by Chen et al. (2021) showed that papaya extract has antiangiogenic activity that can inhibit the growth of cancer cells and increase the immune response. This study reinforces the finding that the bioactive content in papaya contributes to boosting the immune system and improving cell metabolism in cancer patients after consuming papaya jelly candy [20]. Research by Wang et al. (2023) found that beta-carotene and flavonoids in papaya have cytotoxic effects that can improve the body's immune response and speed up the recovery process in cancer patients. Flavonoids are also able to improve cell metabolism and increase immunity [21]. A study by Singh et al. (2022) shows that regular consumption of papaya extract can increase appetite and improve the nutritional status of cancer patients. This is in line with the results of this study, which shows that the regular consumption of papaya jelly candy This study also produced unexpected findings that opened up opportunities for the development of new theories [22].

One of the unexpected findings was that as many as 30% of respondents reported improvements in the digestive system after consuming papaya jelly candy. This effect comes from the papain content in papaya, which has a proteolytic ability to break down proteins into amino acids that are more easily absorbed by the body. A new theory that can be developed is that regular consumption of papain-based food products can be used as an adjunct therapy to improve indigestion in cancer patients. As many as 40% of respondents reported a reduction in nausea and vomiting after consuming papaya jelly candy. This effect can be attributed to the natural sweetness of papaya and its soft texture, which stimulates the production of digestive enzymes and promotes the relaxation of the stomach muscles. A new theory that can be developed is that the combination of flavors and textures in papaya-based foods could be sensory therapy to reduce the side effects of cancer therapy, such as nausea and vomiting. As many as 50% of respondents experienced an increase in the body's immune system after consuming papaya jelly candy. These findings suggest that besides the antioxidant effects of flavonoids and beta-carotene, papain may have immunostimulant properties that can directly increase the body's immune response. A new theory that can be developed is that papain may act as a natural immune booster that can be used in immunological therapy in cancer patients [22].

One of the unexpected findings was that as many as 30% of respondents reported improvements in the digestive system after consuming papaya jelly candy. This effect most likely comes from the papain content in papaya, which has a proteolytic ability to break down proteins into amino acids that are more easily absorbed by the body. A new theory that can be developed is that regular consumption of papain-based food products can be used as an adjunct therapy to improve indigestion in cancer patients. As many as 40% of respondents reported a reduction in nausea and vomiting after consuming papaya jelly candy. This effect can be attributed to the natural sweetness of papaya and its soft texture, which is able to stimulate the production of digestive enzymes and promote relaxation of the stomach muscles. A new theory that can be developed is that the combination of flavors and textures in papaya-based foods could be sensory therapy to reduce the side effects of cancer therapy, such as nausea and vomiting. As many as 50%

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The study involved only 50 respondents, which may not be enough to represent the general cancer patient population. A larger sample is needed to improve the external validity of the research results. The study was conducted over 7 days, which may not be enough to evaluate the long-term impact of papaya gummy consumption on the health status of cancer patients. Longitudinal studies with a longer duration will provide a more accurate picture of the ongoing effects of this product. Further research can compare the effectiveness of papaya jelly candy with other dietary supplement products already available on the market, such as supplements or high-calorie foods. The results of this comparison can strengthen the competitive advantage of papaya jelly candy products as a functional food for cancer patients.

4. CONCLUSION

This study shows that papaya jelly candy has the potential to be a healthy dietary supplement alternative for cancer patients. These candies are well-received in taste, texture, aroma, and packaging and provide significant health benefits such as increased appetite, energy, and the immune system. Further research is recommended to involve a larger sample count and include respondents with more diverse backgrounds, such as variations in cancer type, disease severity, age, and gender. To increase consumer acceptance, flavor and texture variants of papaya-based jelly candies can be developed by adding other natural ingredients such as honey, lemon, or ginger. The combination of these ingredients is expected to not only enhance the taste but also enrich the health benefits through the content of antioxidants and other active substances. Follow-up studies are recommended to evaluate the long-term effects of papaya jelly candy consumption on improving cancer patients' nutritional status, immunity, and quality of life. Longitudinal studies lasting at least 3–6 months will provide a more accurate picture of the product's effectiveness in the long term.

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