Research article

Amygdalin extracts from almonds and apricots as anticancer agents in human oral carcinoma - an in vitro investigation

Alexander Maniangat Luke[1,2*], **Sam Thomas Kuriadom**[1,2], **Krishna Prasad Shetty**[1,2,3], **Mohamed Saleh Hamad Ingagou**[1,2]

1 Department of Clinical Sciences, College of Dentistry, Ajman University, Ajman, UAE.
2 Center for Medical and Bio-Allied Health Sciences Research (CMBHSR), Ajman University, Ajman, UAE
3 Adjunct Faculty, Department of Conservative Dentistry and Endodontics, Manipal College of Dental Science, MAHE Manipal (India)
*Corresponding author: a.luke@ajman.ac.ae

Received date: 11-12-2024
Accepted date: 01-02-2025
Published date 15-03-2025

Article DOI

Abstract: Background: In recent years, the application of complementary medicine to treat an array of conditions, including cancer, has surged in prominence. Investigations have indicated that amygdalin, a naturally occurring chemical derived from plants, has anticarcinogenic impacts on several types of cancer. Method: The current work used human oral cancer cell lines, namely the oral cell line SCC-9, to evaluate the anticarcinogenic impact of amygdalin extracted from almonds and apricots. A meticulous extraction method from fresh apricots and almonds was employed to accomplish this. After that, SCC-9 cells were treated with these extracts at different doses ranging from 0 to 100 µg/ml. Acridine orange/ethidium bromide staining, 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) test, and neutral red uptake assay (NRU) were used to assess the effectiveness of amygdalin. Conclusion: The findings demonstrated the anti-cancer qualities of amygdalin, which is found in almonds and apricots. This demonstrates that it is a therapeutic strategy which can be helpful in treating oral cancer.

Keywords: almond extracts, amygdalin, anticarcinogenic effect, apricot extracts, complementary medicine, oral cancer, SCC-9 cell line.

Introduction

The incidence and fatality rates regarding oral cancer are steadily rising, especially in South Asia, making it a serious worldwide health concern[1,2]. Oral cancer is the 13th most frequent cancer globally, according to latest statistics from the World Health Organization (WHO), and it has a significant negative impact on rates of morbidity and death[3,4]. The Indian subcontinent bears a disproportionate burden of oral cancer, a disease that is nonetheless frighteningly common despite advances in medical treatment techniques [5].

Oral cancer has a complex etiology that includes multiple risk factors, such as drinking alcohol, using tobacco products (smoking and smokeless), chewing betel quid, and being infected with high-risk HPV strains[5-7]. These risk factors are more common in many underdeveloped countries, which helps to explain why oral cancer rates are higher in these areas. Furthermore, the burden of the disease is increased in settings with little resources due to difficulties with early identification and restricted access to high-quality healthcare services. Even if they are somewhat successful, the current treatment options for oral cancer, which include radiation therapy, chemotherapy, and surgical resection, frequently have serious side effects[8,9]. Although necessary for the excision of tumors, surgical operations can cause deformity and functional impairment that significantly lower patients' quality of life[10]. Although the goal of chemotherapy and radiation therapy is to destroy cancer cells, these treatments can cause systemic toxicity and crippling side effects such as myelosuppression, xerostomia, and mucositis.

Given such barriers, it is imperative that novel therapeutic strategies be developed in order to improve the prognosis of patients with oral cancer. Novel approaches including tailored medicine, molecular-targeted treatments, and nano-systems have the potential to increase therapeutic effectiveness while reducing side effects[11,12]. Furthermore, improvements in early detection methods in conjunction with customized treatment approaches provide possible paths toward raising patient survival rates and lowering the burden of disease[13].

The use of complementary and alternative medicine (CAM) techniques as adjuvant treatments for cancer care has grown in popularity. Natural compounds obtained from therapeutic plants, enhanced with phytochemicals and antioxidants, have demonstrated potential in influencing cellular signaling pathways and concentrating on populations of cancer stem cell[14,15]. Among these organic substances, the plant material amygdalin, which may be found in apricots, almonds, and other fruits, has gained attention as a possible anticancer agent with a variety of pharmacological characteristics[16].

Preclinical research has demonstrated that amygdalin may cause programmed cell death, or apoptosis, and can also suppress the growth of cancer cells in a range of cancer types, which is strong evidence of amygdalin's potential as an anticancer drug. The impact of amygdalin on cancer cell lines generated from various organs and tissues, such as the bladder, colon, liver, prostate, non-small cell lung cancer, and oral squamous cell carcinoma (OSCC), has been examined in this research[16-19]. Amygdalin has shown encouraging anticancer capabilities in these preclinical studies by successfully addressing important pathways linked to the survival and proliferation of cancer cells. Amygdalin causes apoptosis, which is a regulated process of cell death that is essential for getting rid of malignant cells and stopping the formation of tumors[16-19]. Furthermore, it has been demonstrated that amygdalin inhibits the growth of cancer cells, which reduces their capacity to proliferate and disseminate[16-19]. Amygdalin exhibits potential in reducing cancer cell migration, invasion, and tumor growth in bladder, breast, prostate, renal, and liver cancers. It acts through modulation of integrin expression, cell cycle regulation, and interference with adhesion to endothelium and extracellular matrix. Additionally, amygdalin influences PI3K-AKT-mTOR and Ras pathways. However, responses to amygdalin treatment may vary among different cancer cell lines in vitro[20-22].

The precise effects of amygdalin on oral cancer cell lines are still largely unknown, despite these hopeful results in a variety of cancer types. The effects of amygdalin on cancer cells originating from other organs have been demonstrated, however its influence on cancer cells originating from the mouth remains unclear[18-23]. Consequently, more research is necessary to fully comprehend amygdalin's therapeutic potential in relation to oral cancer. Research towards amygdalin's effects on oral cancer cell lines in particular can shed light on the drug's mechanisms of action and prospects for use as a targeted treatment for this specific kind of cancer. Through preclinical research designed to assess amygdalin's effectiveness in oral cancer models, scientists can clarify how it affects important cellular functions including apoptosis, proliferation, and metastasis.

Therefore, the aim of this in vitro study was to evaluate the effects of amygdalin on an oral cancer cell line, acknowledging the limits of current therapies for the disease. Its main goals are to clarify the effects of the drug and identify pertinent parameters. The importance is in offering insightful contributions to the field of oral cancer research that might influence future treatment strategies.

Materials and Methods

Ethics approval

This study has obtained approval from the Institutional Research Ethics Committee of Ajman University, UAE (D-H-F-2020 dated 31-08-2020).

Preparation of extract

Fresh apricots and almonds were carefully cleaned with distilled water, allowed to air dry, and then ground into a fine powder. Soxhlation was carried out for six hours after the powder and ethanol were combined in a 1:3 ratio. A rotary evaporator was used to evaporate the resultant ethanolic extract at a temperature of 60°C. The residue, which included an abundance of amygdalin, was collected and kept at -20°C until desired use. Almond and apricot extracts were made in a range of concentrations, 0 to 30 mg/L (3, 6, 9, 12, 15, 18, 21, 24, and 27) and 0 to 42 mg/L (3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39), respectively.

Cell culture

In the present experiment, the human oral squamous cell carcinoma cell line SCC-9 (RRID:CVCL_1685) had been employed. The National Centre for Cell Sciences (NCCS) in Pune, India served as the location the cell line was acquired. Following an exhaustive rinsing in phosphate buffered saline (PBS), the SCC-9 cells were analyzed. Subsequently, they were incubated in Dulbecco's modified Eagle Medium (DMEM), which was enhanced with 10% FBS and 1% penicillin-streptomycin solution. Six-well culture plates were selected to seed the cells, and they were then incubated at 37°C with 5% CO_2. At intervals of two days, the cell culture medium was replaced to introduce new compounds and eliminate waste.

To explore the effects of amygdalin, SCC-9 cells had to be moved to 96-well growth plates at a concentration of 1 x 10^4 cells per well upon having achieved confluence. Various metrics of amygdalin (0, 25, 50, 75, 90, and 100 μg/mL) were applied to the cells, and they were incubated for one whole day. Acridine orange/ethidium bromide staining (AO/EB), the 3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyl tetrazolium bromide (MTT) assay, and the neutral red uptake (NRU) assay were the three techniques used to evaluate cell viability during the incubation time.

Acridine orange/Ethidium bromide (AO/EB) staining

The in vitro grown cells were treated with an acridine orange/ethidium bromide (AO/EB) solution which was produced in phosphate buffered saline (PBS) at a concentration of 100 μg/mL. Under a 400X magnification fluorescence microscope, observations were performed.

Employing this staining technique, necrotic and apoptotic cells displayed red and orange fluorescence, respectively, whereas green fluorescence signified living cells. Acridine orange (AO) is notable for its ability to migrate into both living and dead cells and release a green fluorescence. On the other hand, the nucleus of dead cells that have compromised the integrity of their cytoplasmic membrane are specially stained orange by ethidium bromide (EB). As a result, the appearance of necrotic, apoptotic, and living cells was red, orange, and green, correspondingly.

MTT assay

In phosphate buffered saline (PBS), a solution containing 5 mg/mL of MTT was developed. In a six-well culture plate, bleomycin was applied for 24 hours. Then, 80 μL of the MTT solution was added to each well to measure cytotoxicity. Immediately following that, the plate was incubated for 4 hours at 37ºC with 5% CO_2, during which time the media containing the cells and MTT ended up being blue.

Following incubation, the mixture was gently centrifuged for 10 minutes at 22ºC at 1000 rpm. Soon after the particle was carefully separated from the supernatant, 1 milliliter of 100% dimethyl sulfoxide (DMSO) was used to dissolve it. While being kept in the incubator for an hour at 37ºC with 5% CO_2, this solution developed into purple.

The solution's optical density (OD) was then determined at 570 nm using a spectrophotometer. The equation that follows was used for determining the cell density percentage: Percentage of cell density = 100 X (OD sample - OD blank)/ODcontrol. The MTT solution in DMSO was used as the blank in this investigation. For additional toxicological study, probits of the observed lethality percentage values were employed.

Neutral Red Uptake (NRU) assay

The neutral red solution was produced at a concentration of 100 µg/mL in serum-free Dulbecco's Modified Eagle (DME) medium. Following a 24-hour development period for the oral squamous cell carcinoma (OSCC) cell line in the presence of almond and apricot extracts, each well received 20 µL of the neutral red dye solution. After that, the plate was incubated for three hours at 37ºC with 5% CO_2.

Dead cells remained unstained throughout this incubation, whereas the lysosomes of living cells absorbed the dye. Then, in order to help remove the dye from the lysosomes of living cells, 100 µL of a separately produced neutral red desorption solution—which is made up of 50% ethanol, 1% acetic acid, and 49% distilled water—was added to each well.

A spectrophotometer was implemented to gauge the optical density at 540 nm (OD540) of the washout solution in order to determine the live cell density. These data were then used to compute the percentage values of live cell density.

Results

Both almond and apricot extracts demonstrated anticancer effects on the SCC-9 oral cell line (Fig. 1). The viability of cancerous cells decreased as the concentration of both extracts increased.

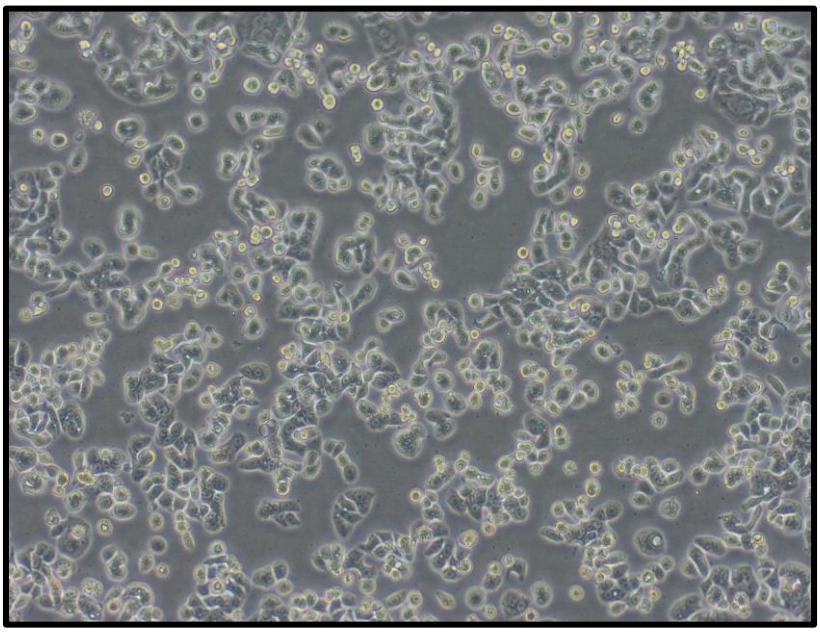

Fig. 1. SCC-9 cell line at 40X magnification after seven days of culture.

AO/EB staining

For the almond extract, the incidence of cellular death increased gradually across the concentration range of 3 to 30 mg/L. In contrast, the apricot extract showed a decline in the number of viable cells starting at values between 3 and 40 mg/L. Experimentally, lethality was noted at 3 mg/L – which was recorded as the MIC value. The HPC was 30 mg/L for the almond extract; for the apricot extract the MIC and HPC were 3 and 42 mg/L, respectively (Fig. 2).

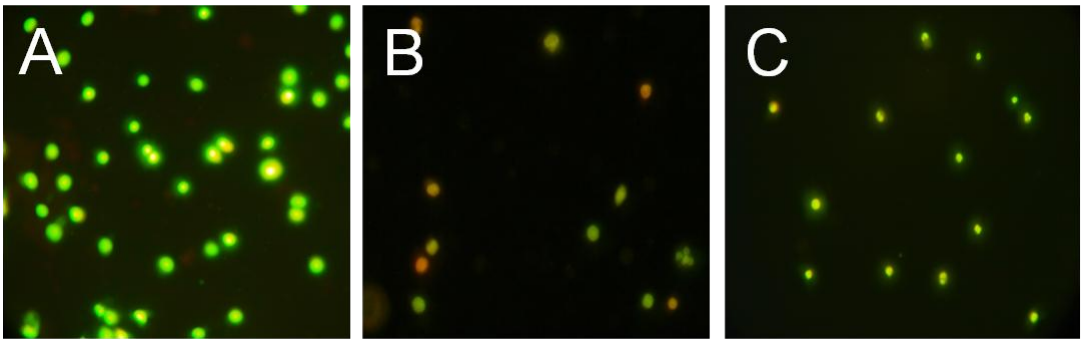

Fig. 2. AO/EB staining. (A) Control cells; (B) Cells after treated with 30 mg/L almond extract; (C) Cells after treated with 30 mg/L apricot extract.

Plotting the values of LC_{25}, LC_{50}, and LC_{75} on a graph, the corresponding log_{10} concentrations for the almond extract were 0.98, 1.17, and 1.34, respectively, while for the apricot extract, the values were 1.12, 1.32, and 1.47 as depicted in Fig. 1. The log_{10} concentration values for almond extract had antilog values of 9.54 (LC_{25}), 14.79 (LC_{50}), and 21.87 (LC_{75}) in mg/L, whereas the computed LC values for apricot extract were 13.18 (LC_{25}), 20.89 (LC_{50}), and 29.51 (LC_{75}) (Table 1 and Fig. 3).

Table 1. Toxicity Values Of Almond And Apricot Extract To SCC-9 Mouth Cell Lines Obtained By Experimentation And The Probit Computation (mg/L).

Assay methods	Almond Extract					Apricot Extract				
	MIC	**LC_{25}**	**LC_{50}**	**LC_{75}**	**HPC**	**MIC**	**LC_{25}**	**LC_{50}**	**LC_{75}**	**HPC**
Acrridine orange/ethidium bromide staining (AO/EB), EB staining	3	9.54	14.79	21.87	30	3	13.18	20.89	29.51	42
MTT (3- 4,5-dimethylthiazol-2-yl -2,5 diphenyl tetrazolium bromide) assay	3	7.41	14.79	26.91	30	3	12.58	20.89	29.51	42
Neutral Red Uptake (NRU) assay	3	10.23	14.79	20.89	30	3	16.59	23.44	30.19	42

MIC:Minimum inhibitory concentration; log10 concentration values: LC25, LC50, and LC75; HPC:Half-lethal concentration.

MTT Assay

Cellular density, as determined by OD570, gradually decreased for the almond extract during the concentration range of 3 to 30 mg/L. The almond extract's Half Lethal Concentration (HPC) was determined to be 30 mg/L, while the Minimum Inhibitory Concentration (MIC) was found to be 3 mg/L by experimental determination. The MIC and HPC for the apricot extract were found to be 3 and 42 mg/L, respectively.

Extrapolated log_{10} values for the almond extract at LC_{25}, LC_{50}, and LC_{75}, respectively, were obtained using graphic representation and were 0.87, 1.17, and 1.43. The apricot extract was found to have corresponding values of 1.10, 1.32, and 1.47. These log_{10} concentration levels therefore corresponded to LC values for the

almond extract of 7.41 (LC_{25}), 14.79 (LC_{50}), and 26.91 mg/L (LC_{75}), and for the apricot extract of 12.58 (LC_{25}), 20.89 (LC_{50}), and 29.51 mg/L (LC_{75}) (see Fig. 4 and Table 2).

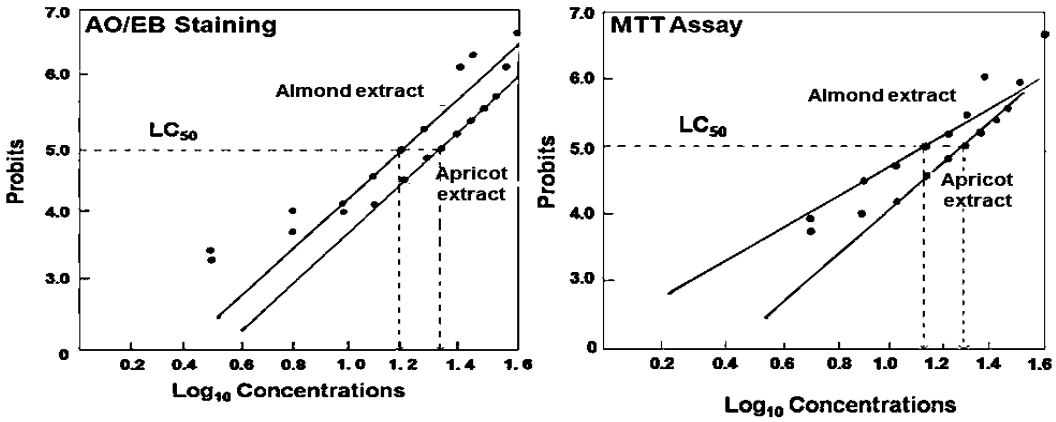

Fig. 3. Probits of percentage lethality values plotted against log_{10} concentrations of almond and apricot extract in the toxicity study of SCC-9 mouth cell line by AO/EB and MTT assay. Each line is fitted by eye; three pairs of log_{10} concentration values were determined taking probit points, 4.3255 (LC_{25}), 5.0000 (LC_{50}) and 5.6745 (LC_{75}).
AO/EB: Acrridine orange/ethidium bromide; MTT: 3- 4,5-dimethylthiazol-2-yl -2,5 diphenyl tetrazolium bromide

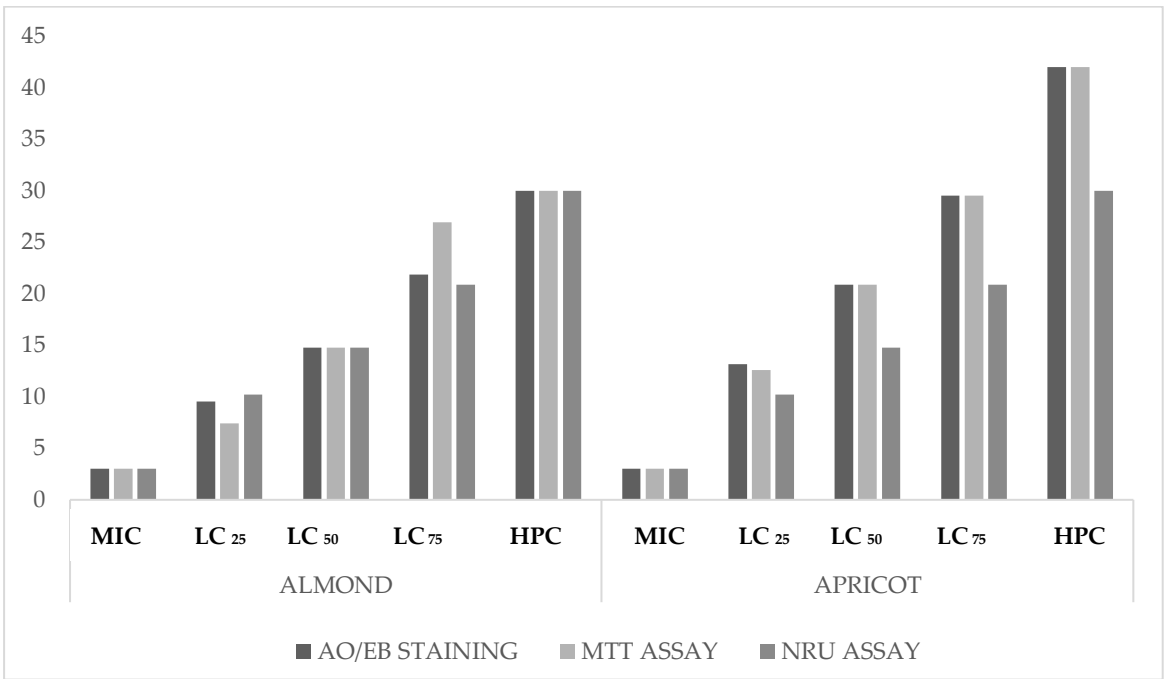

Fig. 4. Histogram of MIC, LC_{25}, LC_{50}, LC_{75}, and HPC values in mg/mL, corresponding to AO/EB, MTT, and NRU assays after the SCC-9 mouth cell lines are treated with almond extract. *AO/EB: Acrridine orange/ethidium bromide; MTT: 3- 4,5-dimethylthiazol-2-yl -2,5 diphenyl tetrazolium bromide; NRU: Neutral Red Uptake; MIC: Minimum inhibitory concentration; log_{10} concentration values: LC_{25}, LC_{50}, and LC_{75}; HPC: Half-lethal concentration.*

Table 2. Lethality Values during Almond Extract and Apricot Extract Toxicity to SCC-9 Cell Line Growing in DMEM, Assessed by AO/EB Staining, MTT Assay, and NRU Assay with Mean ± Standard Deviation.

Concentration (mg/ml)	Lethality of cells by AO/EB staining (%)	Lethality of cells by MTT Assay (%)	Lethality of cells by NRU Assay (%)
Almond Extract			
0	0	0	0
3	8 ± 2.64	6.3 ± 0.69	8.0 ± 1.0
6	19 ± 2.64	14.1 ± 1.65	14.7 ± 2.40
9	23 ± 4.58	31.0 ± 2.83	26.3 ± 2.68
12	38 ± 3.0	41.6 ± 1.21	37.4 ± 0.70
15	51 ± 2.0	50.3 ± 2.60	45.5 ± 0.85
18	63 ± 6.08	60.9 ± 3.47	64.2 ± 2.00
21	76 ± 2.0	71.5 ± 0.72	75.8 ± 3.40
24	89 ± 2.64	87.0 ± 0.98	88.9 ± 2.04
27	93 ± 2.64	93.3 ± 2.10	95.0 ± 1.47
30	97.6 ± 0.57	98.1 ± 0.95	99.0 ± 0.10
Apricot Extract			
0	0	0	0
3	6 ± 2.00	3.9 ± 0.20	2.1 ± 0.26
6	13 ± 6.00	12.1 ± 0.40	5.6 ± 0.70
9	19 ± 4.04	16.5 ± 2.04	9.6 ± 0.91
12	21 ± 7.00	23.2 ± 0.79	17.2 ± 1.24
15	36 ± 2.51	36.3 ± 0.96	19.7 ± 0.72
18	49 ± 4.35	42.6 ± 1.10	38.9 ± 1.51
21	51 ± 2.64	51.3 ± 1.73	46.0 ± 1.57
24	59 ± 3.00	58.0 ± 0.60	54.1 ± 6.42
27	67 ± 4.58	66.7 ± 0.62	62.7 ± 2.45
30	73 ± 4.00	73.9 ± 0.70	69.2 ± 3.19
33	81 ± 1.00	85.1 ± 0.98	79.3 ± 3.93
36	89 ± 2.00	90.9 ± 0.86	85.4 ± 3.50
39	96 ± 1.73	95.7 ± 0.78	94.5 ± 2.49
42	97 ± 0.57	98.3 ± 0.73	98.6 ± 0.37

AO/EB: Acrridine orange/ethidium bromide; MTT: 3- 4,5-dimethylthiazol-2-yl -2,5 diphenyl tetrazolium bromide; NRU: Neutral Red Uptake.

NRU Assay

The cellular density, measured at OD540, showed a progressive decrease in the almond extract concentration range of 3 to 30 mg/L. The almond extract's Half Lethal Concentration (HPC) and Minimum Inhibitory Concentration (MIC) were found to be 3 mg/L and 30 mg/L, respectively, by experimentation. Concentrations of 1.01, 1.17, and 1.32 for LC_{25}, LC_{50}, LC_{75} respectively, were found by extrapolating $\log_{10}$ values from the probit plot for the almond extract. For the apricot extract, the corresponding $\log_{10}$ values were 1.22, 1.37, and 1.48.

These $\log_{10}$ concentration values then corresponded to LC values for the almond extract (Fig. 4 and Table 2) of 10.23 (LC_{25}), 14.79 (LC_{50}), and 20.89 mg/L (LC_{75}) and for the apricot extract (16.59 (LC_{25}), 23.44 (LC_{50}), and 30.19 mg/L (LC_{75}).

Discussion

The cytotoxic effects of amygdalin in different cancer cell lines have been the subject of several research, with an emphasis on the drug's capacity to cause apoptosis and impede tumor development. Previous studies have shown that amygdalin extracts from various natural sources, such as almonds and apricots, have anticancer effects against a variety of cancer types. These investigations have demonstrated amygdalin's capacity to target cancer cells specifically while sparing healthy cells, potentially reducing adverse consequences. Multiple research investigations have shown a concentration-dependent decline in cancer cell viability after treatment with almond and apricot extracts, which is in line with our findings.

Our study's results are consistent with and build on earlier studies on the anticancer effects of amygdalin extracts from apricots and almonds. Almond and apricot extracts had noteworthy anticancer activity against the SCC-9 oral cell line in vitro, which is in accordance with previous research. This is consistent with research like those done by Arshi et al.[24] , and Caroline et al. [25], which showed how amygdalin may kill several kinds of cancer cells, including oral carcinoma. Furthermore, in agreement with preclinical research, we observed a concentration-dependent decline in cancer cell survival, suggesting that amygdalin might cause cytotoxicity in cancer cells at higher doses[24,25]. Furthermore, our work supports earlier research emphasizing the function of amygdalin in inducing apoptosis and suppressing cancer cell growth.

Amygdalin stimulates apoptosis and stops the cell cycle in cancer cells by way of molecular processes that have been clarified by studies[26,27]. By situating our results within the larger framework of studies on amygdalin, we add to the growing body of data that suggests almond and apricot amygdalin extracts may be effective as potential anticancer medicines.

According to a recent study by Askar et al., amygdalin isolated from almonds had strong cytotoxic effects against breast cancer cells, with larger concentrations resulting in enhanced cell death[28]. Cassiem et al.[29] further supported the potential use of these extracts in cancer treatment by demonstrating the effectiveness of amygdalin obtained from apricot in reducing the development of colon cancer cells. Interestingly, our results show that almond extracts had maximum effectiveness at 50 μg/mL, demonstrating their strong antiproliferative action. On the other hand, apricot extract has notable effects at greater doses, most notably at 100 μg/mL[30]. Moreover, it appears that these effects become stronger with time, highlighting the dynamic aspect of their activity[31].

The anticancer effects that extract of almond and apricot amygdalin have been shown to have been probably the result of several different mechanisms working together to maximize their effectiveness. The induction of apoptosis is one important process that is essential for the destruction of cancer cells [16,18]. According to Moradipoodeh et al. [32], amygdalin extracts have been demonstrated to modify apoptotic pathways by upregulating pro-apoptotic genes like Bax and downregulating anti-apoptotic genes like Bcl-2. This mismatch in apoptotic regulatory proteins encourages cancer cells to undergo programmed cell death, which ultimately results in their death. In addition, extracts containing amygdalin from almond and apricot may prevent the growth of cancer cells by obstructing the advancement of the cell cycle. Research has shown that by controlling the production of cyclins and cyclin-dependent kinases (CDKs), these extracts can stop the cell cycle at particular stages, such as the G0/G1 phase[33] . Amygdalin extracts impede tumor development by preventing cancer cells from reproducing uncontrolled through disruption of the normal cell cycle machinery.

Our findings revealed a concentration-dependent response to amygdalin treatment, with higher concentrations exhibiting greater cytotoxicity towards SCC-9 cells[34] . This is evidenced by the significant reduction in cell viability observed in the MTT assay and the increase in apoptotic and necrotic cell populations detected through AO/EB staining. The MTT assay demonstrated a dose-dependent decrease in cell density following amygdalin treatment, indicating its ability to inhibit cell proliferation and induce cytotoxicity [19]. The NRU assay supported these findings by showing a decrease in live cell density following amygdalin treatment, suggesting impairment of lysosomal function and cellular viability[35].

These results align with previous studies demonstrating the anticancer properties of amygdalin in various cancer cell lines. The mechanisms underlying amygdalin's anticancer effects may involve modulation of integrin expression, disruption of cell cycle progression, and interference with cellular adhesion to the extracellular matrix. Additionally, the observed suppression of the PI3K-AKT-mTOR and Ras pathways may contribute to the inhibition of cancer cell migration and invasion [36,37].

Besides, it is possible that the anticancer effects of almond and apricot amygdalin extracts stem from the interference of important signaling pathways linked to the advancement of tumors [38]. For instance, it is well known that the Wnt/β-catenin pathway controls cell survival, proliferation, and differentiation; abnormal activation of this system is frequently seen in a variety of malignancies. Research has demonstrated that extracts containing amygdalin may repress Wnt/β-catenin signaling, which in turn can prevent the growth of cancer cells and trigger their death [39]. Almond and apricot amygdalin extracts have strong anticancer properties and show potential as therapeutic agents for the treatment of cancer by focusing on these signaling pathways.

For a thorough knowledge of the therapeutic potential of almond and apricot amygdalin extracts in the treatment of cancer, further clarification of these processes is imperative. Through the deciphering of the complex molecular mechanisms by which these extracts elicit their anticancer effects, scientists will be able to pinpoint new targets for intervention and create more potent anticancer therapy approaches.

Additionally, amygdalin sensitized hepatocellular carcinoma cells to cisplatin treatment, suggesting that it may be used as an adjuvant therapy in the treatment of cancer[40]. Together, these results highlight the many pathways via which amygdalin demonstrates its anticancer properties and provide information on the drug's prospective use in the treatment of cancer.

There is currently minimal clinical data to support amygdalin's effectiveness as an anticancer treatment in people, despite encouraging preclinical study outcomes. There are several obstacles that prevent its use in therapeutic settings. First of all, amygdalin's bioavailability raises questions since different people absorb and distribute it differently in the body, which might affect how effective it is. Furthermore, there is a great deal of variation in the chemical makeup of amygdalin extracts derived from various natural sources, including apricots and almonds, which may have an impact on their pharmacological characteristics and therapeutic results.

Additionally, there are safety concerns regarding the possible harmful consequences of amygdalin, especially its conversion to cyanide in the body, which calls for cautious dose adjustment and monitoring. These difficulties highlight the need for more investigation to thoroughly assess the effectiveness, safety, and ideal dosage schedules of amygdalin in therapeutic contexts. For clinical trials to offer solid proof of their therapeutic potential and direct the creation of successful cancer treatment plans, well defined research designs and outcomes are crucial. Solving these issues will be essential to realizing amygdalin's full potential as a promising cancer treatment alternative.

The results of our investigation indicate that extracts of almond and apricot amygdalin may be useful as adjunctive or alternative therapies for oral carcinoma and maybe other cancers. Subsequent investigations ought to concentrate on clarifying their modes of operation, refining extraction techniques, carrying out clinical trials, investigating synergistic impacts with traditional treatments, and detecting biomarkers for customized therapeutic approaches.

Although our study provides insightful information, it has limits. The in vitro nature limits its capacity to mimic the intricate in vivo tumor microenvironment. Furthermore, the variability of human oral carcinoma may not be well represented by a single cancer cell line. The safety, bioavailability, ideal dosage, possible medication interactions, and long-term effects of almond and apricot amygdalin extracts in clinical settings require more investigation.

Conclusions

The results of this investigation show that human oral squamous cell carcinoma cell lines are resistant to cancer when amygdalin, which is derived from almonds and apricots, is applied. However, amygdalin from almonds is more effective than amygdalin from apricots. As a result, extracts from almonds and apricots, which are rich sources of amygdalin, may find use in regenerative medicine.

Conflicts of Interest

The authors declare no conflicts of interest.

Author contributions:

AML and STK; study conception and design. AML and STK; Formal analysis; KPS and MSHI; Methodology. AML and STK; Writing-original draft. KPS and MSHI; Writing-review & editing. Supervision; AML and STK. All authors reviewed the results and approved the final version of the manuscript to be published.

Institutional Review Board Statement

The Institutional Research Ethics Committee of Ajman University

granted consent for the study, which was carried out in compliance with the Declaration of Helsinki (D-H-F-2020, dated August 31, 2020).

Informed Consent Statement

Not applicable.

Data Availability Statement

The corresponding author may provide the data from this study upon request.

Funding and Acknowledgments

This research was supported by Ajman University Internal Research Grant No. DRG Ref. Number. 2020-IRG-DEN-01 . We acknowledge and thank the research assistant, Dr. Rajashree Patnaik, for her technical expertise and administrative assistance. The research findings presented in this paper are solely the responsibility of the authors.

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مستخلصات الأميغدالين من اللوز والمشمش كعوامل مضادة للسرطان في سرطان الفم البشري - دراسة مختبرية

ألكسندر مانيانغات لوك، سام توماس كوريا دوم، كريشنا براساد شيتي، محمد صالح حمد إنجاكو

المستخلص:

في السنوات الأخيرة، شهد استخدام الطب التكميلي لعلاج مجموعة واسعة من الحالات، بما في ذلك السرطان، ازديادًا كبيرًا في الأهمية. أشارت الدراسات إلى أن الأميغدالين، وهو مركب كيميائي طبيعي مستخرج من النباتات، له تأثيرات مضادة للسرطان على عدة أنواع من السرطان. استهدفت الدراسة الحالية تقييم التأثير المضاد للسرطان لمركب الأميغدالين المستخرج من اللوز والمشمش باستخدام خطوط خلايا سرطان الفم البشري، وتحديدًا خط الخلايا .SCC-9 تم استخدام طريقة استخراج دقيقة من المشمش واللوز الطازج لتحقيق ذلك. وبعد ذلك، تمت معالجة خلايا SCC-9 بهذه المستخلصات بجرعات مختلفة تتراوح بين 0 و100 ميكروغرام/مل. تم تقييم فعالية الأميغدالين باستخدام تقنيات تلطيخ أورانج أكريدين/إيثيديوم بروميد، اختبار MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide)، واختبار امتصاص الأحمر المحايد .(NRU) أظهرت النتائج الخصائص المضادة للسرطان للأميغدالين الموجود في اللوز والمشمش، مما يشير إلى أنه يمكن أن يكون نهجًا علاجيًا مفيدًا في علاج سرطان الفم