Apigenin and Kaempferol Effects on Oral Cancer FaDu cells

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INTRODUCTION

Flavonoids, a group of naturally occurring compounds found abundantly in fruits and vegetables, has recently received much attention in cancer chemoprevention. There have been numerous epidemiologic studies, laboratory studies, and human clinical trials indicating that flavonoids have important chemopreventative properties.[1] The proposed mechanisms of action include carcinogen inactivation, cell cycle arrest, induction of apoptosis, promotion of differentiation, and inhibition of angiogenesis.[1-3]

Our current study utilizes two flavonoids, apigenin and kaempferol, that have been shown to effectively inhibit agonist binding to the aryl hydrocarbon receptor.[4] This ligand activated cytosolic receptor translocates to the nucleus and regulates expression of target genes involved in procarcinogen activation.[5-9] Know agonists of the AHR are the polycyclic aromatic hydrocarbons and polyhalogenated hydrocarbons both of which are present in large quantities in cigarette smoke.[10] Since oral squamous cell carcinoma is clearly linked to smoking, we are interested as to whether apigenin and kaempferol inhibit cell proliferation in a malignant oral cell line both *in vitro* and *in vivo*

METHODS

In vitro model

The experiments were conducted with FaDu cells, a well know human squamous cell carcinoma cell line established from a tumor of the upper aerodigestive tract. Following incubation for 24 hours the cells were treated with increasing concentrations (0.1, 1, 10, 25, 50, and 100 micromolar) of each kaempferol and apigenin. Following 24 and 48 hours of treatment cell viability was determined using the WST-1 assay. The data was analyzed using one-way ANOVA and Tukey's multiple comparison tests.

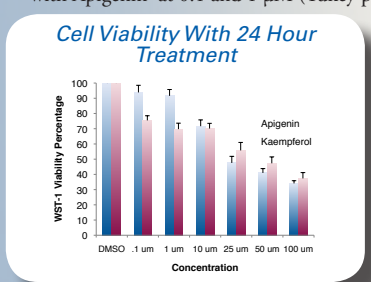
In vivo model

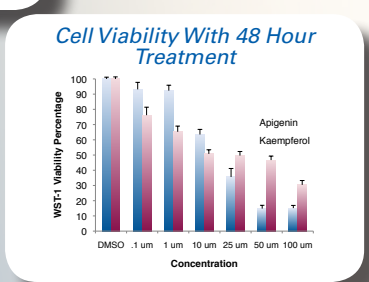
Athymic nude mice at approximately 6 wks of age were used for the experiments. Three groups of nude mice (10 to 12 mice/group) were treated by gavage for one week prior to inoculation. Group 1 was treated with 50ug kaempferol per day via gavage five days per week for at least one week prior to inoculation and continued until sacrifice. Group 2 was treated in the same fashion with 50ug apigenin per day via gavage. Group 3 or the control group was treated with corn oil in the same fashion. After 1 week of gavage the left flank of each nude mouse was injected subcutaneously with 0.1 ml (1x105 cells) of FaDu cell suspension. The right flank of each mouse served as control and was injected with 0.1 ml of Matrigel mixed with cell free culture medium. The mice were maintained under pathogen free conditions. Once the tumor became palpable, the volume was regularly monitored, measuring the length, width, and height of tumors. Tumors were weighed at sacrifice at 28 days after inoculation.

RESULTS

In vitro model

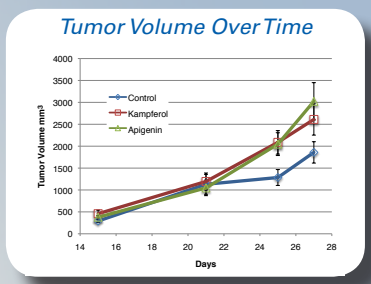
- Cell viability decreases in the 24 and 48 hour treated FaDu cells with increasing concentrations of both kaempferol and apigenin ($p < 0.001$)
- The response is more pronounced in the 48 hour treated cells.
- All conditions were significantly different from controls except the cells treated with Apigenin at 0.1 and 1 µM (Tukey $p < 0.001$)

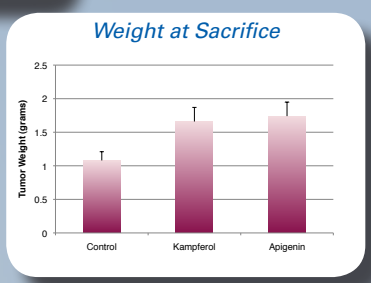




In vivo model

- Apigenin group's tumor volume was **significantly higher** than controls ($p<0.03$, average volume of $3024mm^3$ versus $1858mm^3$)
- The Kaempferol group's tumor volume was **higher** than controls ($2610mm^3$ vs. $1858mm^3$, but this did not reach statistical significance $p<0.09$).
- The tumor weights at time of harvest for the control group, kaempferol group, and apigenin control group were 1.08 grams, 1.66 grams, and 1.74 grams respectively.
- We saw no evidence of overt kaempferol or apigenin toxicity. Each group of test mice showed similar weight gain throughout the experiment.





DISCUSSION

Our study shows that increasing concentrations of both apigenin and kaempferol inhibit cell proliferation in a dose dependent manner. Thus, as the concentration of the flavonoid is increased, cell proliferation is proportionately decreased. This replicates what has been shown in various human solid tumor cell lines. Little in vivo study of human tumor models has been reported to extend this information.

Our animal model failed to show tumor growth inhibition when the animals were treated with either apigenin or kaempferol. In fact, tumor burden actually increased when animals were treated with apigenin or kaempferol. This would suggest that these compounds may be poor chemopreventative agents. This is in stark contrast to previous reported experience with apigenin in prostate carcinoma cell lines. Shukla *et al* investigated the *in vivo* growth inhibitory effects of apigenin on human prostate carcinoma in athymic nude mice. Their results showed a significant reduction in tumor volume by 59% ($p < 0.0001$). It is clear that the response of transplanted xenografts tumors to treatment with apigenin is vastly different for human prostate cancer cell lines than FaDu squamous carcinoma cell lines.

Whether our observed decrease in cell line proliferation is the result of apoptosis or direct cytotoxic effects must be determined. Further molecular studies are ongoing to elicit the mechanism of action. The in vivo results demand further exploration. In vivo exploration of these drugs on other solid tumors and other H&N SCCA cell lines are needed. The differences in the tumor milieu, proteomics and genetic events are currently under investigation in our labs.

CONCLUSION

- Treatment of oral squamous carcinoma cell lines with apigenin and kaempferol in culture results in a dose dependent reduction in cell viability.
- Apigenin and Kaempferol increase tumor growth in athymic mice.
- Translational work examining these flavonoids as SCCA chemopreventative agents would be unwise until this phenomenon is better understood.

FINANCIAL DISCLOSURES

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