# PRODUCTION OF PREVITAMIN $D_3$ BY A MERCURY ARC LAMP AND A HYBRID INCANDESCENT/MERCURY ARC LAMP

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## Introduction

Most vertebrates including reptiles and amphibians need a source of ultraviolet B radiation in order to promote an adequate production of vitamin D to satisfy their body's requirement (**1**). Reptiles routinely sun themselves, not only to warm their bodies, but also to produce vitamin $D_3$ in their skin. Amphibians exposed to sunlight also have the ability to produce vitamin $D_3$ in their skin (**1**). It is estimated that there are over ten million households in the United States that have a reptile or amphibian as a pet. Often these animals are housed in a glass enclosure, and are exposed to incandescent lighting. Since incandescent lighting does not emit any ultraviolet B radiation, these animals depend solely on their diet for their vitamin D requirement. Frequently, diets including vegetable matter or live or dead animals do not contain an adequate amount of vitamin D to satisfy their requirements resulting in these animals developing severe vitamin D deficiency. Vitamin D deficiency causes rickets and osteomalacia that can lead to fractures, muscle weakness and ultimately, death. Many zoos also house reptiles and amphibians indoors, in glass enclosures and often experience vitamin D deficiency in these prized animals. The appreciation that these animals require a source of ultraviolet B radiation has prompted the lamp manufactures and distributors to produce florescent lamps that emit ultraviolet B radiation **that are similar to lamps used in tanning salons**. These lamp systems have produced mixed results in preventing vitamin D deficiency bone disease in captive reptiles and amphibians. The goal of this research program was to evaluate a new hybrid incandescent lamp that contains a mercury arc system that emits radiation with energies above 290 nm. This system was compared to a mercury arc Sperti lamp system, and natural sunlight for its capacity to produce previtamin D in an ampoule system (**2**).

### Methods

Crystalline 7-dehydrocholesterol was dissolved in methanol at a concentration of 50 µg/ ml. Borasilicate ampoules were filled **with** 1 cc of the 7-DHC solution. The ampoules were exposed to a Sperti lamp (**Fig 1**) (KBD Inc. Erlanger, KY) for 10 minutes at varying distances. Ampoules

were placed 6 inches from the Westron incandescent lamps (**Fig 2)** and samples were obtained at various times for up to one hour. Ampoules were also placed on the roof of a ten-story building within the Boston Medical Center campus in the middle of June on a cloudless day at noon**time**.

After the samples were collected, they were immediately stored at -20°C. The ampoules were opened and the contents removed. An aliquot of each sample was taken to dryness and chromatographed on a straight phase high performance liquid chromatography system as previously described (**2**).

**Results**

Exposure of ampoules to the Sperti lamp system revealed that at a distance of 1 foot, approximately 8% of 7-DHC was converted to previtamin $D_3$ in 10 minutes (**Fig 3**). There was almost a 4-fold reduction in the percent production of previtamin $D_3$ in ampoules that were exposed to the Sperti lamp for 10 minutes at a distance of 2 feet. The amount of previtamin $D_3$ continued to decrease as the distance from the Sperti lamp increased. Essentially no previtamin $D_3$ was detected in samples that were exposed to the Sperti lamp system at a distance of 6 feet from it (**Fig 3**).

Regulating the lamp power with a transformer had a significant impact on previtamin D formation in the ampoules as shown in Figure **4**.

A comparison of previtamin $D_3$ formation between the Sperti sunlamp system and natural sunlight in Boston in June is shown in Figure **5**. Percent conversion of 7-DHC to previtamin $D_3$ in June in Boston at noontime was approximately **1.0,** 2.5 and 3.5 % at 10, 20 and 30 minutes **respectively**. In comparison **at** one minute, the Sperti lamp system at a distance of 6 inches converted 1% of 7-DHC to previtamin $D_3$ and after 10 minutes, 10% of 7-DHC was converted to previtamin $D_3$. (**Fig 3**).

An evaluation of the effectiveness of the Westron lamp to produce previtamin $D_3$ in the ampoule system **was performed**. Ampoules were exposed to 6 different Westron Lamps at a distance of 6 inches for up to 1 hour. As can be seen in Figure **6** between 1 and 2% of 7-DHC was converted to previtamin $D_3$ after 15 minutes and after one hour of exposure, between 3 and 5% of 7-DHC was converted to previtamin $D_3$.

**Conclusion**

It is recognized that ultraviolet radiation with energies between 255 and 315 nm is effective in photolyzing 7-DHC to previtamin $D_3$ (Fig **7**). An evaluation of the spectral output for the Sperti mercury arc lamp system shows significant emission of ultraviolet radiation above 280 nm. The

spectral output of the Westron lamp revealed emission of ultraviolet radiation with energies above 290 nm. Thus, both the Sperti sunlamp system and the Westron sunlamp systems emit radiation that would be effective converting 7-DHC to previtamin $D_3$. Our results conclusively demonstrate that both the Sperti lamp system and Westron lamp systems have the capacity to produce previtamin $D_3$. Thus, both systems should be of value both for inducing vitamin $D_3$ in reptiles and amphibians that are housed indoors as pets or in zoos. In addition, they may be of value in preventing vitamin D deficiency in individuals who either can not absorb vitamin D from dietary sources due to fat malabsorption syndrome, or because they are infirmed and are unable to be exposed to sunlight.

We have used the Westron lamp as a means of preventing vitamin D deficiency in our mated pair of Euromastix mali **lizards** as demonstrated in Figure 7.

In conclusion, it is reasonable that vertebrates who normally obtain their vitamin D requirement from exposure to sunlight, and are kept as pets or as specimens in zoos should be exposed to a source of ultraviolet B radiation to satisfy their vitamin D requirement if they are not getting an adequate amount from their diet. The Sperti sunlamp system, Westron sunlamp system and several of the commercial fluorescent lamps that emit ultraviolet B radiation are good sources for this vital photobiologic process.

**References:**

1. Holick, Peter ____

2. Tian

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