Nanotechnology in Agriculture
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Lecture-30
Antioxidant Nanomaterial in Skeletal Muscle Development Part-II

Welcome back to the lecture series in role of nanomaterials in agriculture, so we are into the animal production section. So the question where I ended my previous lecture was could antioxidant therapy improve endurance of skeletal muscle.

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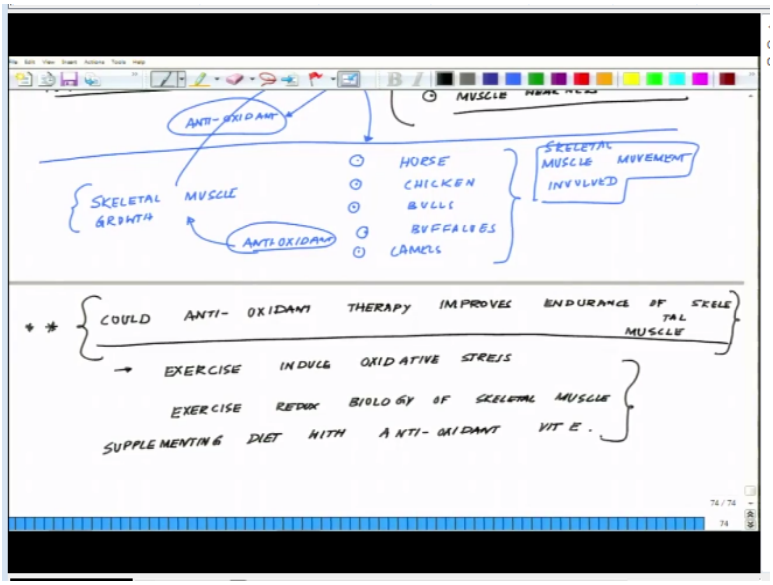

Because I mentioned you that during exercise it generates reactive oxygen species.

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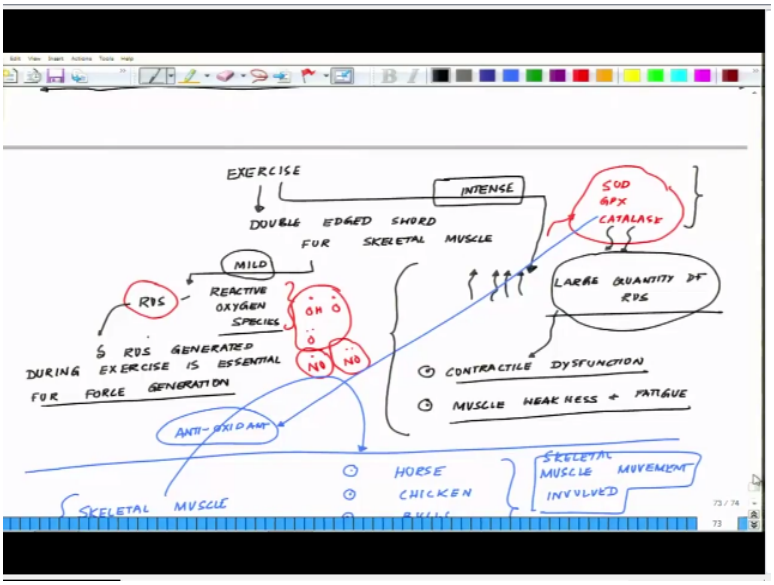

And those ROS are essential for generation of contractile forces but during intense exercise there is a large quantity of reactive oxygen species which is generated, unless otherwise your system is well equipped with fully functional, so peroxide dismutase, glutathione peroxidase or catalyze you if they are not well equipped with it. Then you may suffer from contractile dysfunction, muscle weakness and fatigue ok.

So according to the current understanding our skeletal muscle physiology ROS or free radical at low and physiological level is essential for normal force production ok whereas at higher level of ROS causes contractile dysfunction resulting in muscle weakness and fatigue. Such ROS mediated skeletal muscle tissue damage often occurs during intense physical exercise and is termed as is the term used for it exercise induce oxidative stress**.**

Thus the level of ROS forms the pivot which regulates the exercise redox biology of the skeletal muscle exercise. Now one of the option is supplementing diet with antioxidants like Vitamin E ok**.** And these attempts has been attempted to reduce the ROS load or reactive oxygen species load in the skeletal muscle.

Thus reducing the ROS meditated oxidative damage, single large scale intervention experiment using high doses of anti-oxidant offered disappointing result. So what has been observe that this studies where such animals have been supplemented with heavy doses of anti-oxidants are which

are mostly if you look at Vitamin E, the structure of Vitamin E. These are huge molecules ok, the results were disappointing, now that very critical and that needs a very same thinking.

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Now again take you back to one of the previous classes when I talk to you naturally occurring anti-oxidant molecule if you remember it remember. So, this naturally occurring anti-oxidant molecule these are huge molecules something like this. And I told you these are used in food additive in a industry, but these huge molecules when you are putting into the system. In order to counter the ROS they may have their own side effects to because body is not used to consume these molecules in huge amount like if you take a lot of Vitamins.

It is normally help you really I mean you may not even need Vitamin because body may function with a very trace amount of it, we need vitamin the what I am mean to say you may not need vitamin supplementation really at times. We always get oh take as much as possible that is a very wrong concept, that does not work because body has its own weight in a conserve them. Now if you are supplementing the diet with lot of they say for example in this case.

The whole trial failed of vitamin E as an anti-oxidant it completely failed it did not work because their issues with such kind of trials. So what was I was trying to highlight is that just because we believe this going to work will work it does not happened like that and that was the reason why I

highlighted this part when there are these kind of huge molecules like this, they may come with their whole series of side effects and may not work.

So, we need an optimal quantity, so this is the area where nano may come pretty handy where the quantity is extremely low some delta quantity we are talking and the effect is very profound and when you talk about something like cerium which is needed in extremely small quantity going by the reaction which is having a pseudo infinite half life.

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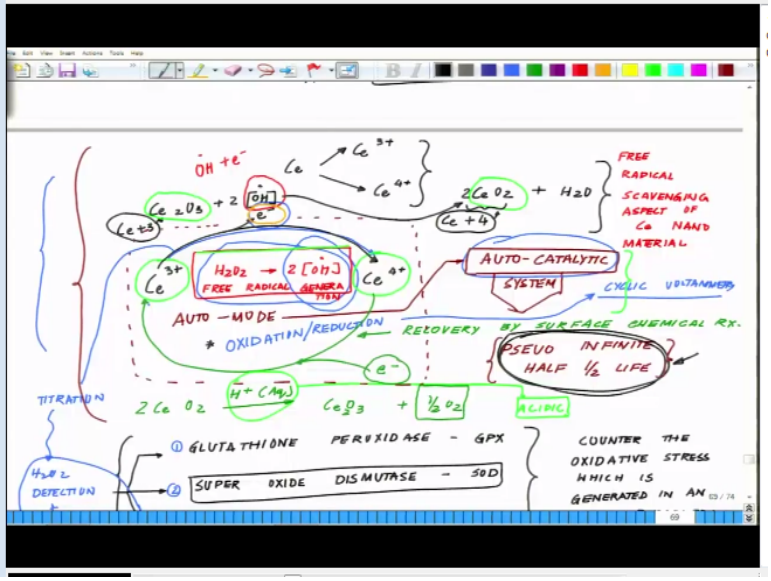

Then the story line completely changes, so getting back what are the things which were observe was the single large scale intervention experiments using high doses of anti-oxidant of a disappointing result that does anti-oxidant nutrition studies as a therapeutic approach remained in conclusive till this date.

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It is one of the most inconclusive study that whether anti-oxidant therapy is good for animal production or not or at least increasing their skeletal muscle endurance and all other stuff is it possible.

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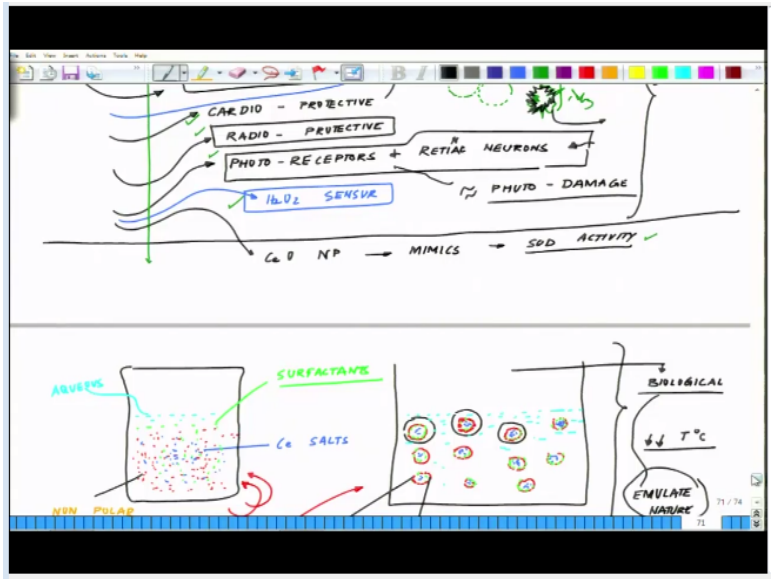

And it is very very inconclusive, but then at that time there was one study which was conducted using cerium oxide nanoparticle instead of vitamin E.

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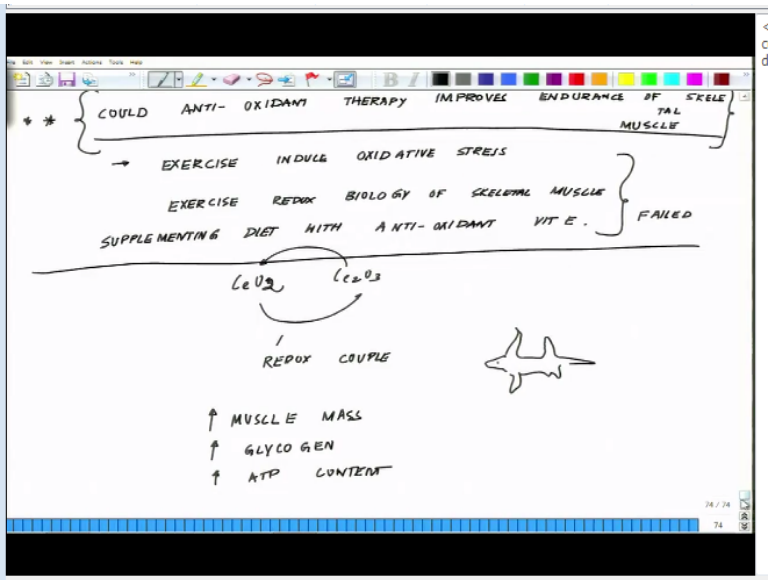

This failed ok could you use Ceo2, Ce2o3 sorry could you use this redox couple in a skeletal muscle and the whole idea was the key question is how cerium oxide exhibits such myriad effect and we have already talked about it ok, so now here this one study showed a very interesting result it has been introduced into the rat by intro-muscular injection ok. So, basically this whole trial was done on rats something like this ok.

It has been introduced into the rat by intra-muscular injection and the skeletal muscle endurance has been evaluated, intra-muscular injection of cerium oxide concurrent with exercise. You have to do the exercise you have to make the rat go through the exercise it enhances there is 2, 3 things which enhances. It enhances the muscle mass was a huge enhancing muscle mass, there was an increase in glycogen, there was an increase in ATP content once again ok.

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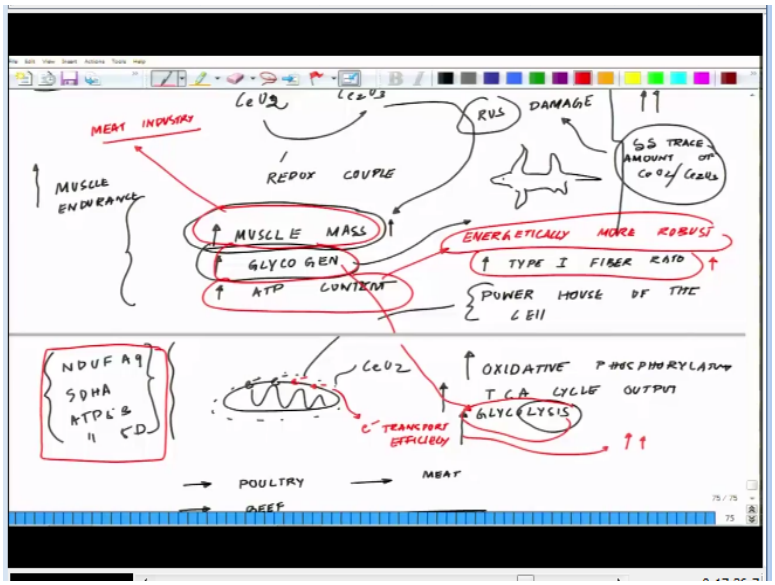

And type-I fiber ratio was increasing, so these are the different fiber ratio of the skeletal muscle, thus resulting a significantly higher muscle endurance, there is a higher muscle endurance. So electron microscopic studies confirm the presence of cerium oxide nanoparticle in the vicinity of muscle mitochondria, the power house of the cell. So there were presence of the cerium oxide and what is the significance will come about it very soon.

Thus there was an increase in the number and the size of the muscle mitochondria in the cerium oxide nanoparticle treated muscle following exercise as compared to the untreated growth with only exercise muscle. And apart from it the quantitative protonix data and subsequent biological network analysis studies identified higher level of oxidative phosphorylation, the major energy generation reaction of the body of the biological system TCS cycle output, tri-carboxylic acid cycle output ok.

And glycolysis breaking down of the glycogen lysis ok glycolysis ok and this was further associative this significant increase in the mitochondrial respiratory capacity and muscle contraction primarily due to the higher level of electron transport chain proteins like, so all the electron transport chains which are proteins which are involved are NDUF A9, SDHA, ATP5B, ATP5D ok and was all these were evaluated by ICPMS data.

And which reveal clearance of the particles after 90 days without exhibiting any inflammatory or adverse effect on the health of the experimental animal. Thus a higher physiological endurance of cerium oxide nanoparticles supplemented exercise muscle opens a new avenue for skeletal muscle therapeutics space and sports medicine. So what if you look at the data very carefully.

It results in increasing muscle mass, in other word what you are countering is that infinite pseudo infinite half-life is countering the ROS damage like countering the ROS damage your ensuring there is a increase in the muscle mass, further if there is a increase in muscle mass there will be more glycogen, those rich carbohydrates which are present there which are ensuring that it could generate lot more energy.

Now if you look at the mitochondrial chain, electron transport chain there is an increase in electron transport protein concentration. In other word the efficiency of the mitochondria which is the power house of the cell, so the efficiency of the mitochondria is increase. Because there is more oxidative phosphorylation, there is more glycolysis, there is more TCA cycle output. So instead of using heavy doses of where the study field if you look at it.

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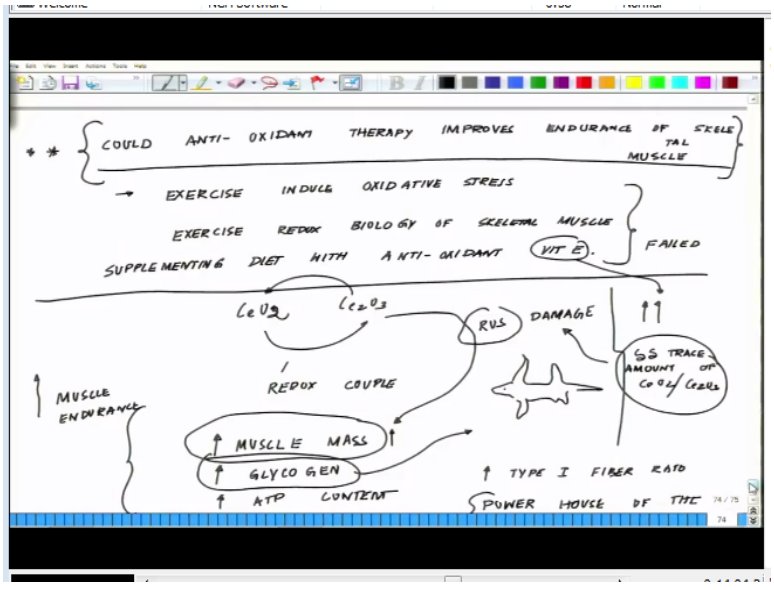

In case of Vitamin E instead of using heavy doses of Vitamin E if you use a trace very trace amount of CeO2. You may get totally dramatic results in a skeletal muscle, this is very very

interesting finding in terms of increasing animal production, this study could be translated in poultry where your meat production is extremely important ok.

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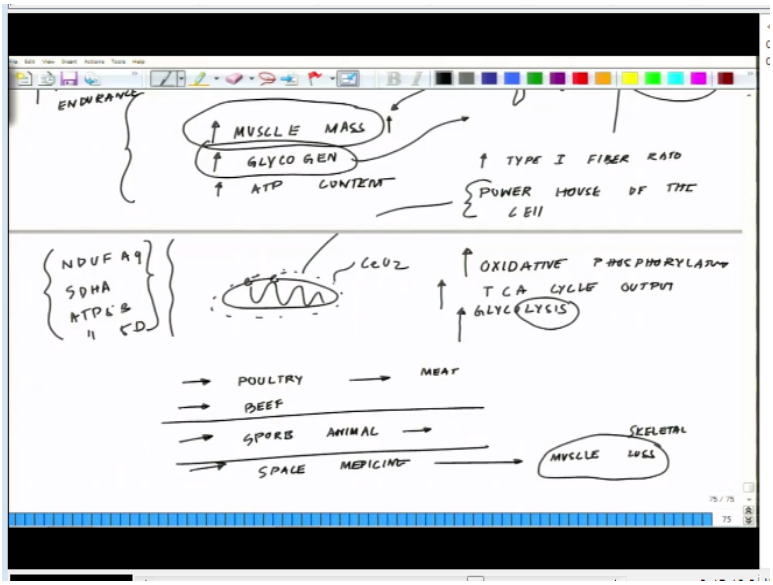

One area where for meat similar if for beef, similar is the situation for sports animal, similar is in space medicine. Because if you look at the space there is huge amount of muscle loss especially the skeletal mostly the skeletal muscle loss, if you see the data from NASA and other space agency and the world ISRO, NASA and all other agencies they will tell you the Russian agencies French agencies, Chinese agencies.

If you look at them you would see most they come back because of the no gravity, there is huge amount of skeletal muscle of how we can counter it. You need something in a very trace amount and we does wanted and this particular 5 atom or 3 atom in organic molecule is doing wonders. I mean the data is in front of you but the trace amount, where the biggest trial failed is a increase in muscle mass which is very very critical for the meat industry nutritionally this is higher glycogen concentration.

So the ATP content is increasing, so it means it has more energetically, more robust, this is a type-I fiber ratio which has gone up. This is very critical apart from it you are breaking down more of the glycogen like glycolysis and of course this part in future people will study how we

can increase the percentage or concentration of electron transport chain proteins. So, in other word your electron transport efficiency in the mitochondria is increased.

So, these kind of a studies are laying the foundation stone of application of nanomaterials in animal production and could open up all together new avenue to explore nanomaterial in a very trace amounts of course one has to be an some of these studies are clearly seen within 50 days it is getting cleared up from the body or not, so because you are using a very trace amount and even if it kind of these trace amount remains in the bone.

It is not going to effective because in the bones along with calcium they may form complexes and they would remain there without you know really hardening your system. So some of these studies in decades to come will lay a firm footing into the animal production world and small story which started back in UCF university of center Florida Orlando somewhere on 2003, 2004 is now almost there where it is a technology as small discovery in if you look at it all its application.

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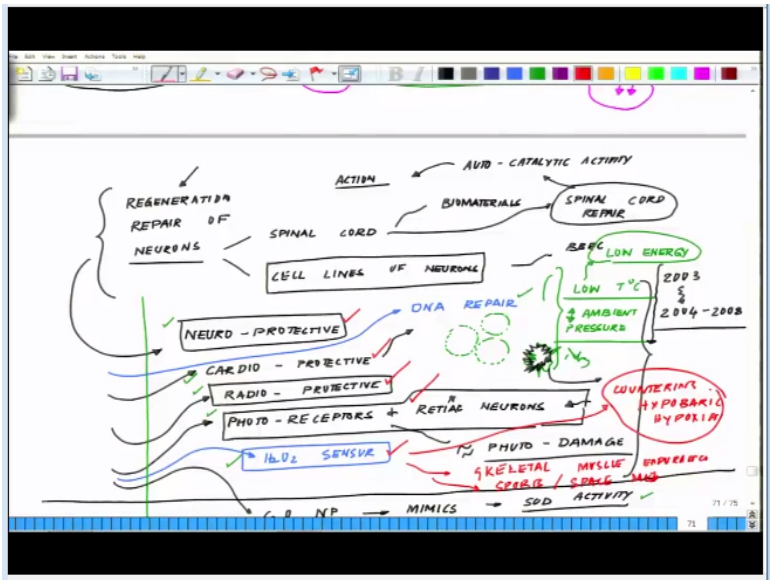

Neuro-protective or its spinal cord repair cardio-protective for the heart, radio protective for cancer therapy, photo receptor for retinal damage, H2O2 sensor for application. And now adding up to that skeletal muscle endurance studies and may be sports medicine and a space medicine,

apart from it found application in countering hypobaric as low pressure hypoxia low oxygen survival.

So, in other word animal production in places like (()) (19:54) have lower oxygen tension these kind of administrating this kind of molecules could make tremendous difference in the animal production. So I am closing here and I will provide you all the reading materials, the papers which have introduce in this area, there will kind of help you to appreciate the feel how it has emerged out from a small space.

And today it is one of the very important nanomaterial which is finding wide range of application from human to the animal world, thank you.