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BIOFORTIFICATION FOR VITAMIN A IN COW'S MILK THROUGH FEEDING FOLIAGE OF GOLDEN SWEET POTATO

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ABSTRACT

Cow's milk is yellow in colour due to the presence of Beta Carotene (precursor of Vitamin A) and is valued over buffalo milk. Dairy cows hardly receive any source of Beta Carotene in their feed and thus their milk is no longer a source of Vitamin A. In eastern U. P. more than 40%, children suffer due to lack of Vitamin A. Some modern dairies do import lot of Vitamin A fortified feed supplement. Thus looking for feed supplement for Vitamin A is doubly important for Vitamin A, reducing import of feed supplement and in increasing Vitamin A content in milk. Stem and leaves of Golden Sweet Potato (GSP) are rich in Beta Carotene. GSP stem and leaf contain respectively 1776 and 1833 microgram of Beta Carotene per 100 grams of fresh material, equivalent to 2447 and 2664 microgram of Vitamin A. Upon feeding GSP stems and leaves, the Beta Carotene content of the milk increased from the first day itself. By the 5th day it increased to 0.69µg± 0.01 from the initial value of 0.47µg± 0.01. Therefore, the stem and leaves of GSP can profitably be used for substituting imported supplement, and thereby increasing Vitamin A content of the cows' milk.

KEYWORDS

Vitamin A, OFSP, GSP, Golden Sweet Potato, Supplementation and Beta Carotene.

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INTRODUCTION

Vitamin A is a group of unsaturated nutritional organic compounds (Anon. 2003, Anon. 2009[1], Anon. 2012[2], Anon. 2016a[3] and Anon. 2016b[3]) that includes retinol, retinal, retinoic acid, and pro-vitamin A carotenoids (most notably beta-carotene). Vitamin A can be found in two principal forms in foods; first is Retinol, the form of vitamin A absorbed when eating animal food sources, is a yellow, fat-soluble substance. Since the pure alcohol form is unstable, the vitamin is found in tissues in a form of retinyl ester. It is also commercially produced and administered as esters such as retinyl acetate or palmitate. The orange pigment of carrots (beta-carotene) can be represented as two connected retinyl groups, which are used in the body to contribute to vitamin A levels (Wolf 2001).

Second is the carotenes like alpha-carotene, beta-carotene, gamma-carotene; and the xanthophyll beta-cryptoxanthin (all of which contain beta-ionone rings), but no other carotenoids, function as provitamin A in herbivores and omnivore animals, which possess the enzyme beta-carotene 15 (DeMan 1999[4], Fennema 2008)[5]. 15'-dioxygenase which cleaves beta-carotene in the intestinal mucosa and converts it to retinol. In general, carnivores are poor converters of ionone-containing carotenoids, and pure carnivores such as cats and ferrets lack beta-carotene 15, 15'-dioxygenase and cannot convert any carotenoids to retinal (resulting in *none* of the carotenoids being forms of vitamin A for these species).

Beta-carotene is a red-orange pigment found in plants and fruits, especially carrots and colourful vegetables. The name beta-carotene comes from the GREEK "BETA" and Latin "CAROTA" (CARROT). It is yellow/orange pigment that gives vegetables and fruits their rich colours. Fennema, (1831) crystallized beta-carotene from carrot roots, and came up with name "carotene". Beta-carotene's chemical formula- C40H56 was discovered in 1907 (DeMan, 1999)[4].

Beta-carotene from food is safe source of vitamin-A through vegetarian diet. Milk is the only vegetarian food which has some Vitamin A. The human body converts beta-carotene into Vitamin-A (Retinol). In the non-vegetarian diet, Vitamin A is taken as such as the animal tissue, especially liver has plenty of Vitamin A. Human body has not to covert it but absorb it as such. Vitamin A is essential for normal growth development, function of immune system and vision. Beta-carotene might help older people retain their lung strength as they age. Beta-carotene has a lower risk of some cancers and heart diseases. Beta-carotene supplements may help people with specific health problem. It is directly involved in vision and extreme deficiency may result into night blindness among adults, and eye defects among infants. It is also related with level of disease resistance including diarrhoea (Chaudhary and Sahani, 2017[6]. In cows deficient in Vitamin A, the milk becomes white like that of buffalo. Chew and Johnston[7].

When cows raw milk (Unhomogenised) is kept in a container undisturbed for a while, the fat globules will rise to the surface. The fat globules have Beta-Carotene, coming from grass and plants that the cows feed on. Beta-carotene has a yellowish things. Still most fresh milk will look white in colour. However, the butter fat content can vary with diet fed to the cows. Such as, a very heavy content in their feed can result in a light yellow colouring to the milk.

Milk contains 87% water and 13% solid and if not pure white contains yellowish/orange pigment that comes from the grass which cows eat. If cows' feed lacks green grass, its milk may remain white and the consumer don't get Vitamin A after consuming it.

MATERIAL AND METHODS

A milch cow was selected which was receiving no green grass or any supplementation in her diet. This cow was fed with 14 kg of green stem and leaf in addition to her usual Wheat *Bhusa*. Milk was collected from the first day (no supplementary feed of GSP) till next 5 days. The stem and leaves were analysed (R-FRAC, 2017). The leaves contain 0.8% fat, 5.01% protein, 8.2% carbohydrate, 2.1% fibre, 1833 microgram Beta Carotene, 1.2 mg of Iron , 0.3 mg Zinc, and 0.36 mg of Manganese per 100 gram of leaf. The stems contain 0.4% fat, 8.62% protein, 11.2% carbohydrate, 2.6% fibre, 1776 microgram Beta carotene, 1.3 mg of Iron, 0.32 mg Zinc, and 0.39 mg of Manganese per 100 gram of leaf.

From the researches done at PRDF, it was clear that GSP variety ST-14 has the highest amount of Beta carotene in its leaves, tubers and stem. Since after harvest of tubers, farmers throw the stem, we decided to use it as feed. Our experimental duration was 12 June 2017 to 16 June 2017. On the first day we selected the cow then we separated her feeding pot from other cows (Figure No.1, 2, 3). General information about the cow and its feeding was collected (Figure No.4, 5, 6). Then we collected her milk which is without supplementary feed. The following day we fed her the fodder of ST-14 variety of weighing about 18 kilograms. This supplemental feeding continued for next 4 days. Every day we collected the milk and analysed for Purity of milk (lactometer reading), Fat Analysis and Beta-Carotene Analysis.

To see the effect on milk fat and to check the purity of milk we go on Parag Factory at Nausad, Gorakhpur (Figure No.2, 3, and 4). The Beta-Carotene analysis was done at the Department of Bio-Technology of Deen Dayal Upadhyay (DDU) University, Gorakhpur.

At Parag Factory Gorakhpur, Gerber Method was used for fat analysis. There Lactometer Test for Purity of milk was used. The Beta-Carotene Analysis was done using Colorimeter method at Biotechnology Department of DDU Gorakhpur.

Analysis of purity of milk

A Lactometer is an instrument that is used to check for the purity of milk by measuring its density. An instrument to find out the content of the water in the milk or to test the richness of the milk is thus termed as **'lactometer'**. The lactometer works on the principle of density of milk.

- If it sinks up to the mark 'M' which mentioned at lactometer that means milk is pure or if not that means milk is impure.
- If the milk is mixed in water then it would sink higher then marked 'M'.
- If it stands at the mark 3 that means milk is 75% pure and respectively 2 for 50% purity and 1 means 25% purity.

Analysis of Beta-Carotene of milk

Colorimeter (an instrument for measuring the intensity of colour) was used for the analysis of Beta Carotene in milk. In scientific fields the word generally refers to the device that measures absorbance of particular wave length of light by a specific solution. Wave-length of Beta-Carotene is 475nm. First the milk was filtered with the help of filter-paper. After centrifuging, the fat of milk was separated from the milk. Then the separated fat s taken in a test-tube and put in the colorimeter. After waiting for few minutes, the reading appears. The analysis of milk fat and the purity of milk as done at Parag Factory at Nausad, Gorakhpur is given Table No.1.

RESULTS AND DISCUSSION

The Beta-Carotene analysis as done at the Department of Bio-Technology of Deen Dayal Upadhyay (DDU) University, Gorakhpur is also given in Table No.1. Golden Sweet Potato (GSP) is rich in Beta Carotene and other nutrients as revealed in the tests done at R-FRAC (Table No.1). The Beta-Carotene analysis of the milk as done at the Department of Bio-Technology of Deen Dayal Upadhyay (DDU) University, Gorakhpur is given in Table No.2. It is clear that if GSP stems and leaves are fed to the cows, it filters down in the milk. With the normal cattle feed, the milk is devoid of Beta Carotene. Chew and Johnston (1985)[7], carried out Vitamin A/day, 173,000 IU/day or 53,000IU/day plus 300 mg of supplemental beta-carotene/day. Supplementation commenced three weeks before calving and continued through 10 weeks of lactation. The vitamin A plus beta-carotene treatment reduced mastitis.

To remedy the Vitamin A deficiency Chaudhary and Sahani (2017)[6] introduced Orange-fleshed Sweet Potato. Cultivation procedures of this newly established variety was perfected (Chaudhary *et al.* 2017)[6]. Using its various parts (leaf, stem, and tubers), biofortification was suggested (Chaudhary *et al.* 2016a[7], 2016b)[8]. Now its stem and tuber available with farmers can be fed to cows to get biofortified Beta Carotene rich milk purposefully. On one hand, the crop residue of GSP will be used as cattle feed and another hand Vitamin A rich milk will be produced. Besides, it will be an import substitution for the expensive and imported Vitamin A rich supplement being imported in the country.

Table No.1: Nutrient content of stem and leaves of Golden Sweet Potato (GSP) as analysed at Regional food Research and Analysis Centre (R-FRAC) Lucknow

S.No	Parameter	Stem	Leaves	Test method used
1	Fat %	0.4	0.8	AOAC
2	Protein %	8.62	5.01	AOAC978.04
3	Carbohydrate %	11.2	8.2	SP: 18 (-6) 1981
4	Beta Carotene µg / 100 g	1776	1833	IS: 512-1988
5	Vitamin A µg / 100 g	2664	2447	IS: 5886-1970
6	Fibre %	2.6	2.1	IS: 10226 (P-1) 1982
7	Iron, mg / 100 g	1.3	1.2	SP: 18 (P-1) 1980
8	Zinc, mg / 100 g	0.32	0.30	AAS Flame
9	Manganese, mg / 100 g	0.39	0.36	AAS Flame

Table No.2: Analysis of milk for Beta Carotene, milk fat and milk density. Day 1 was June 12 of 2017 when milk was collected without any supplementary feeding

S.No	Factor	Day 1	Day 2	Day 3	Day 4	Day 5
1	Beta Carotene	0.47µg± 0.01	0.61µg± 0.01	0.60µg± 0.01	0.70µg± 0.01	0.69µg± 0.01
2	Fat	5.4g± 0.09	5.9g± 0.11	3.9g± 0.01	3.1g± 0.01	3.5g± 0.01

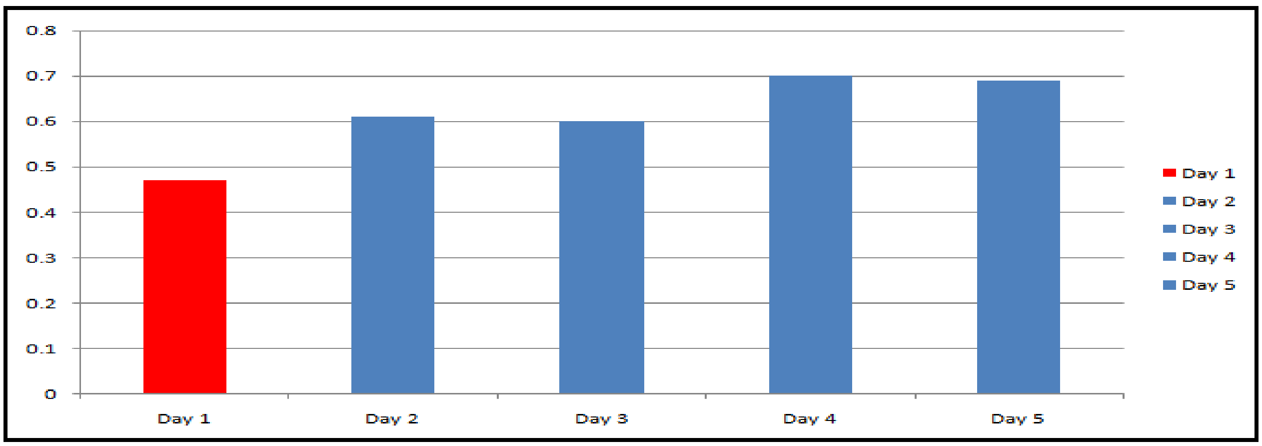

Figure No.1: Effect of feeding GSP stem and leaves to cow on the Beta Carotene content of milk

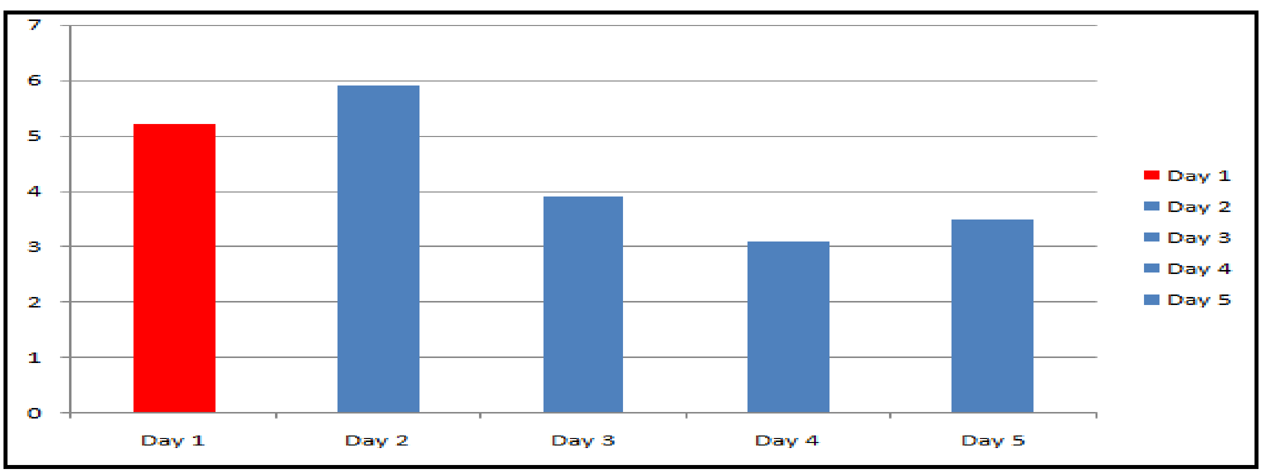

Figure No.2: Effect of feeding GSP stem and leaves to cow on the fat content of the milk

CONCLUSION

Cow's milk has Beta Carotene (precursor of Vitamin A). Dairy cows hardly receive any source of Beta Carotene in their feed and thus their milk is no longer a source of Vitamin A. In eastern U. P. more than 40%, children suffer due to lack of Vitamin A. Some modern dairies do import lot of Vitamin A fortified feed supplement. Stem and leaves of Golden Sweet Potato (GSP) are rich in Beta Carotene and contain respectively 1776 and 1833 microgram of Beta Carotene per 100 grams of fresh material, equivalent to 2447 and 2664 microgram of Vitamin A. Upon feeding GSP stems and leaves, the Beta Carotene content of the milk increased from the first day itself. By the 5^{th} day it increased to 0.69µg± 0.01 from the initial value of 0.47µg± 0.01. Therefore, the stem and leaves of GSP can profitably be used for substituting imported supplement, and thereby increasing Vitamin A content of the cows' milk.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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