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## *Calf Note #246 – EFSA Scientific Opinion on Welfare of Calves, Part 1*

### Introduction

In February of 2023, The European Food Safety Agency (**EFSA**) published a Scientific Opinion entitled "Welfare of Calves" (EFSA, 2023). A committee of experts developed this document as a guide to governments within the European Union to develop regulations and laws to protect and promote the welfare of young calves. The document surely will become the basis for many recommendations, too, for producers and consumers who wish to ensure that calf welfare is protected during the growing period.

The mandate from the European Commission to EFSA was to "*give an independent view on the protection of calves*" (EFSA, 2023). The request to EFSA was to describe current husbandry systems and practices; relevant welfare consequences and measures to assess these consequences; identify hazards leading to these welfare consequences; and recommendations to prevent, mitigate or correct the welfare consequences. The "relevant" consequences were not necessarily based on a data-driven risk assessment, but on the EFSA's expert opinion.

Much of the text refers to male calves raised for veal within the EU. While many of the recommendations may have been made in the context of veal farming, many don't distinguish among male calves raised for veal, male calves raised for non-veal beef production, or replacement dairy heifers. Therefore, it is possible that these recommendations may be implemented (in terms of legislation) to all calf raising systems and this is not always reasonable.

### A Fiber Requirement

One important recommendation of the EFSA Committee was related to feeding forage to young calves and the welfare aspects of limiting forage. The specific recommendation (EFSA, 2023) was:

> *The relationship between NDF amount and rumination behaviour was estimated via an adapted expert elicitation procedure. It was estimated that a mean daily intake of 1 kg of NDF is needed for calves aged 2 weeks to 6 months, to show the full extent of rumination behaviour that would be observed in a calf with no restriction of fibre. It was estimated that, when provided a restricted amount of fibre (assumed as on average 0.19 kg NDF/day), calves would spend on average 5.5 less hours ruminating than if provided fibre ad libitum.*
>
> *It is recommended that from 2 to 8 weeks of age, calves are provided with a total of 11 kg of NDF, between weeks 9 and 18 a total of 65 kg of NDF, and between weeks 18 and 25 a total of 90 kg of NDF, reaching a total of 166 kg per rearing cycle.*
>
> *Fibre with a minimum of 40–50% NDF and in long-cut form (minimum 4–5 cm long) should be provided to allow for chewing and manipulation behaviours. Straw should not be provided as the only ad libitum roughage due to its coarseness and potential detrimental effects on the abomasum.*
>
> *Importantly, additional factors, other than fibre, can influence levels of rumination, such as type of feed, calf breed or time of the day.*

### First, Some Definitions

Let's "unpack" this recommendation, firstly by defining "NDF". Of course, neutral detergent fiber (**NDF**) is a chemical measure of the cell wall constituents of a feed ingredient. The role of physically effective fiber and adequacy of fiber in ruminant diets is well understood (e.g., Zebeli et al., 2012). Most plant feed sources

contain some NDF. Thus, it is not really a measure of the effectiveness of fiber, nor the ability of a feedstuff to elicit rumination. Finely ground concentrates like corn or soybean hulls, usually included in the concentrate portion of a calf's diet, contain NDF. However, they contribute minimally (if at all) to rumination in a calf. Therefore, we will assume that the Committee's use of "NDF" in this context actually refers to "forage NDF" in a form with sufficient particle size to elicit rumination. The Committee recommended forage containing 40 to 50% NDF with a minimum length of 4 to 5 cm.

Also, the Committee uses the term "provided" – I assume that the intention is that the calves are meant to consume the amounts provided, so assume that "provided" equals "consumed". This is confirmed by the caption in Figure 1, wherein the Committee refers to "…ingested solid feed over time".

Let's take a deeper look into how the Committee determined the requirements for dietary NDF for calves of different ages.

**NDF and Intake**

The EFSA Committee recommended that calves from 2 to 8 weeks of age should be provided with a total of 11 kg of forage. They assumed a linear increase in voluntary dry feed intake, based on data from Webb et al. (2014) as shown in Figure 1. Herein lies the first major problem. Simply put, young calves don't eat this way. When calves – whether veal or replacement calves – are fed significant amounts of whole milk or milk replacer, they don't begin to eat dry feed or NDF in a linear fashion as outlined in Figure 1. The actual curve of dry feed intake is curvilinear, not linear. And, when calves consume more milk, the lag prior to increasing amounts of dry feed intake is greater. This is the case for both herd replacement calves and veal calves. In 2020, we conducted a meta-analysis of the effect of milk replacer feeding rates on growth and intake of calf starter (Hu et al., 2020) in herd replacement calves. Figure 2 is from that manuscript. Calves were fed a moderate amount of CMR (~680 g/d) to weaning at about 42 d of age or a high amount of CMR (up to 1.2 kg/d) to weaning at 42 or 49 d of age. During the first eight weeks of all the studies in this meta-analysis, calves were fed CMR and ad lib starter and no long hay. Note that early in life, calves don't eat much dry feed, as they get the majority of their nutrients from milk or milk replacer. As they get older, the amount of dry feed (including starter or hay, when offered) will increase to provide needed nutrients for growth. Reducing energy intake from CMR boosts the intake of starter.

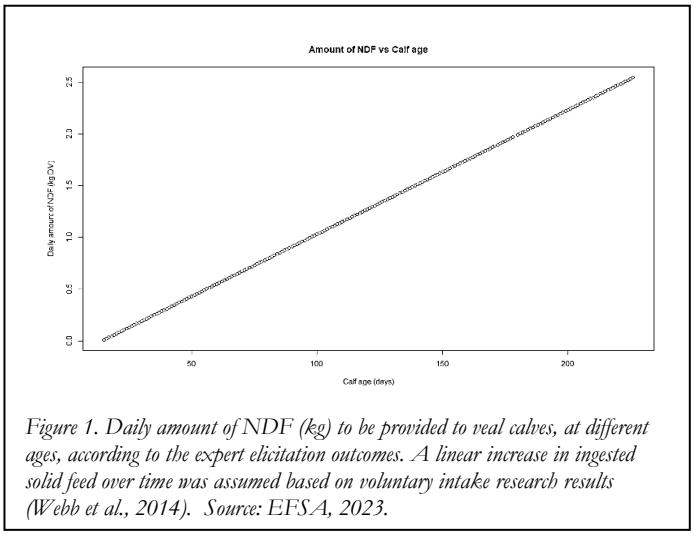


*Figure 1. Daily amount of NDF (kg) to be provided to veal calves, at different ages, according to the expert elicitation outcomes. A linear increase in ingested solid feed over time was assumed based on voluntary intake research results (Webb et al., 2014). Source: EFSA, 2023.*

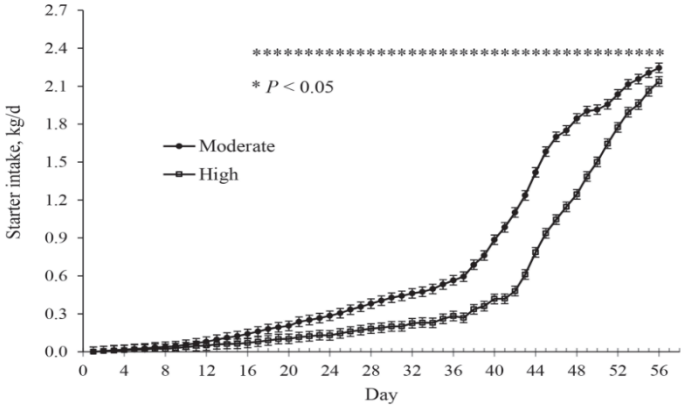


*Figure 2. Starter intake pattern for Holstein calves fed moderate or high rates of milk replacer in the nursery period. From: Hu et al., 2020.*

The EFSA Committee's data (Figure 1) is based on data from Webb (2014). The Committee wrote: "*An experimental study investigating feed preferences of calves showed that the voluntary intake of solid feed increased almost linearly as the calf aged when calves were provided different options (milk, hay, concentrate, maize and*

*straw) (Webb et al., 2014a). Based on these data, a linear increase in ingested NDF as the calf grows older was assumed."*
Let's go back to the paper by Webb et al. (2014a) to see the linearity of solid feed intake for veal calves. The actual intake graph from the paper is in Figure 3. Recall that calves were two weeks of age at the initiation of the trial, so week 1 in the graph is actual 3 weeks of age.

You can see clearly that concentrate intake (light gray line) is curvilinear, following a pattern similar to herd replacement calves (see figure 2) fed large amounts of liquid (no step down of CMR). Both intake of hay and straw are also curvilinear throughout the trial, though they followed different patterns.

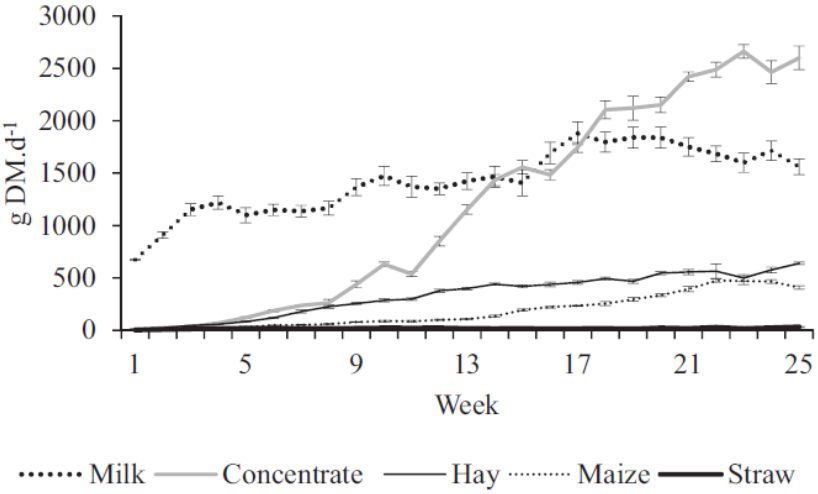


*Figure 3. Intake of feeds by veal calves from 1 to 25 wk of the study (3 to 27 wk of age). Source: Webb et al., 2014.*

I estimated intakes from Figure 3 and calculated the voluntary intake of NDF from hay and corn silage, using the reported NDF concentrations of 59% and 39.9% of DM, respectively. Voluntary forage NDF intake is in Figure 4, along with my estimates of NDF intake required by EFSA from Figure 1. As you can see, calves didn't begin eating forage NDF until about 7 weeks of age. The evolution of intake is curvilinear, not linear. Maximum NDF intake was 560 g/d at 27 weeks of age. The comparison with recommendations from EFSA are stark.

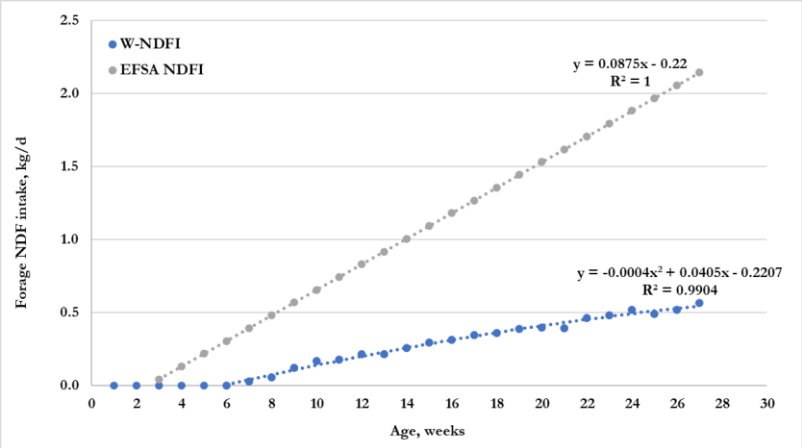


*Figure 4. Calculated forage NDF intake estimated from hay and corn silage intake of calves fed high amounts of CMR. Estimated from Webb et al., 2014 and EFSA (2023).*

Using ad libitum intake of dry feed from Figure 4, I calculated the % of dry feed consumed as forage and as concentrate. The values are in Figure 5. Calves initially began consuming grain and forage in a 60:40 ratio, but then ate proportionally less forage with advancing age to approximately 19 weeks of age, when the grain to forage ratio was 70 : 30. Using this info, let's take the EFSA recommendation to its logical conclusion. Let's assume that at 19 weeks of age, a calf will eat gain : forage in approximately 70:30. At 19 weeks, EFSA recommends that a calf should consume 1.4 kg of NDF. Assuming forage = 50% NDF, then total intake of forage = 2.8 kg. If forage is 30% of the ration, then the calf would consume a total of 2.8 / 30% = 9.3 kg total DMI and 9.3 – 2.8 = 6.5 kg of grain DM. Data from Webb et al. (2014) indicated that, at 19 weeks of age, a veal calf would consume about 2.5 kg of dry feed DM. The difference (9.3 vs. 2.5 kg/d of total dry feed intake) indicate clearly that daily requirements recommended by EFSA don't conform to what we understand about the biology of the calf.

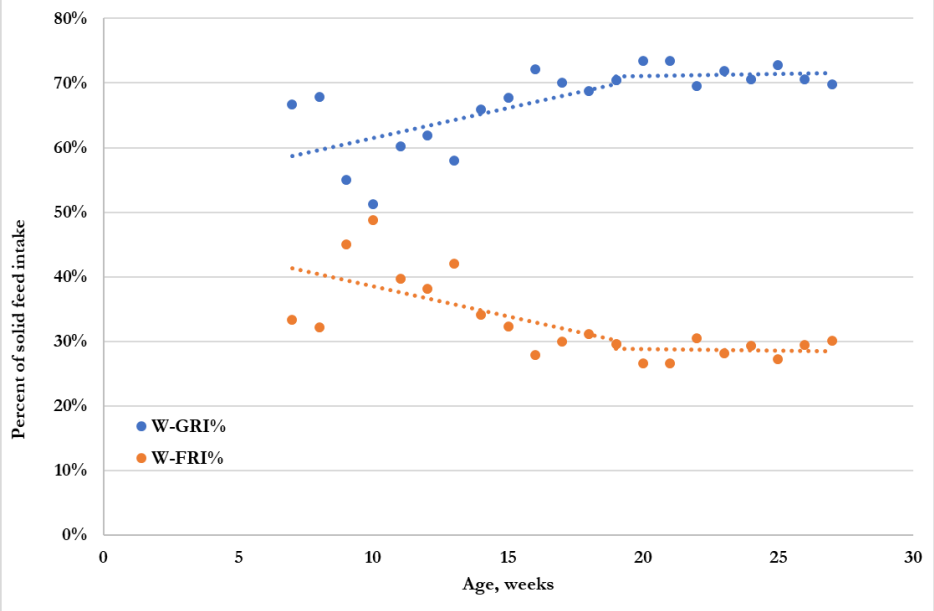


*Figure 5. Percent of forage (W-FRI%) and grain (W-GRI%) consumed by calves fed ad libitum amounts of grain, hay, corn silage, and straw. Calculated from Webb et al., 2014.*

The EFSA Committee estimated that a calf will consume about 400 grams of NDF at six weeks of age (Figure 1). Assuming the forage offered contains 50% NDF, that means the calf is expected to consume about 800 grams of forage DM per day at six weeks. The dry feed prediction equation published by my colleagues and I (Quigley et al., 2021) predicts that calves fed up to 1 kg of milk solids per day and offered ad lib forage with 50% NDF will eat a total of 400 grams of **total DM** at 6 weeks. So, the EFSA Committee overestimates DM intake by at least two-fold compared to published predictions. Further, if we feed a 6-week-old calf ONLY forage containing 50% NDF, what will happen? Our calf will only weigh about 59 kg instead of our target of 67 kg, or a reduction of about 12%. I will explain this further in the next section.

**NDF and Growth**

The next problem with the EFSA recommendation is energy supply for growth. I used a proprietary calf growth model to simulate growth of a Holstein calf weighing 42 kg at birth to 4 months of age. I simulated growth to 4 months of age, using dozens of different allocations of milk, grain, and forage – always assuming that calves will eat quantities of forage indicated by EFSA in Figure 1. None work. That is, none will allow for adequate growth when forage intake is set to amounts recommended by EFSA. For example, if I feed a 6 week old calf 800 g/d of forage, it's necessary to feed at least 1 kg of dry matter from milk to maintain adequate growth rates. This allocation of milk will depress dry feed intake (high amounts of energy from milk effectively depresses dry feed intake) so it's impossible to reach the 800 g/d allocation of forage while maintaining growth. If I reduce the milk allocation to 700 g of powder/day so calves would possibly eat 800

g/d of forage, the calf will gain only about 600 g per day. If I extrapolate through 8 weeks of age, calves are predicted to weigh 71 kg, which is only about 85% of our goal for BW gain at 2 months of age.

Xiao et al. (2023) evaluated effects of age when forage was offered to calves with intake and growth. Calves (n = 84) were offered hay at 5 d, 8 d, or 12 d of age. A fourth control group was only offered concentrate. All calves were fed treatments to 84 days of age. Whole milk was fed at 8 to 10 L/day to weaning at 57 d of age. Their results showed that offering hay early reduced BW gain and nutrient digestion. The authors concluded "*Generally, starting to voluntarily consume forage earlier in life tended to negatively affect the growth of the calf in the short- and long-term. These calves might have had limited capacity to digest the solid feed and utilize the digestible nutrients compared to calves that began later or consumed starter only. However, similar rumination time and rumen fermentation were found among groups, suggesting that the differences in growth were not related to the development of rumination behavior.*"

**Importance of growth on welfare**

It is well known that a high rate of growth in the first weeks of life is paramount for optimal technical and financial results later in life of dairy cattle (lower age at first calving, higher milk yield in the first lactation). It can also be argued that a low growth linked to low CMR intake or poor-quality dry feed is associated with feelings of hunger causing stress and thus leading to poor welfare. For example, a low CMR feeding rate in the first weeks after birth results in lower play behaviour (Krachun et al., 2010; Rosenberger et al., 2017), more vocalization and more non-nutritive suckling behaviour (Thomas et al. 2001; Jongman et al., 2020). High calf growth rates give better development of the intestinal immune system and better resistance against infectious diseases (Hammon et al., 2020). So, the EFSA's narrow view on rumination behaviour without taking play and suckling behaviour and disease and stress into consideration is a questionable approach of calf welfare.

**Voluntary Forage Intake**

The final problem with the EFSA recommendation is voluntary forage intake. Data from veal calves was presented in Figure 3. Webb et al. (2014) also reported significant variability among calves in forage intake. Figure 6 shows the average daily intake of hay of calves in their study. Note that one calf ate essentially no hay while another averaged about 700 g/d.

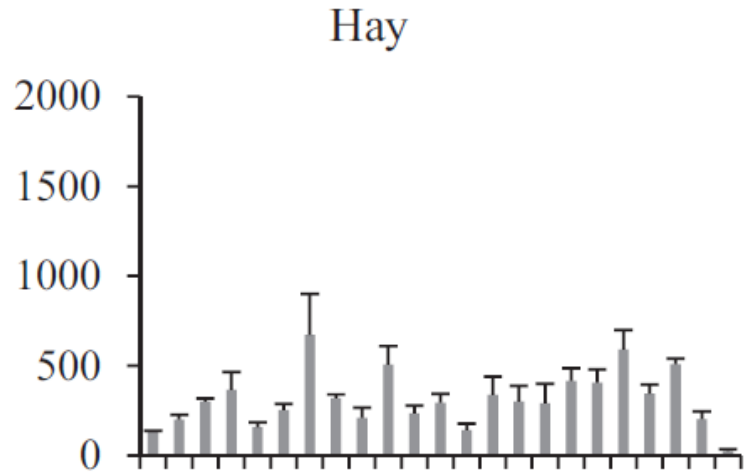


*Figure 6. Variation in daily hay intake of veal calves fed CMR and ad libitum grain, hay, corn silage, and straw. From: Webb et al., 2014.*

There are similar data from studies conducted with herd replacement calves. Figure 7 is from a study conducted by Aragona et al. (2020). The researchers monitored ad libitum forage intake (10.1 to 14.7% CP; 51 to 57% NDF). These calves were also fed calf starter ad libitum to a maximum of 2.3 or 2.7 kg/d. Calves were 8 wk of age when they began the study, which compared different starter compositions with forage

intake. It's noteworthy that calves fed ad libitum forage with limited calf starter intake consumed an average of 2.3 kg/d of starter (the maximum allotted) and 0.6 kg/d of forage, meaning a starter:forage ratio of 80:20. Average daily gain was 17% lower than when calves were fed a TMR of 95% starter and 5% chopped forage. By 16 weeks of age, calves weighed 133 kg, which is well below our target BW of 143 kg at 4 months of age.

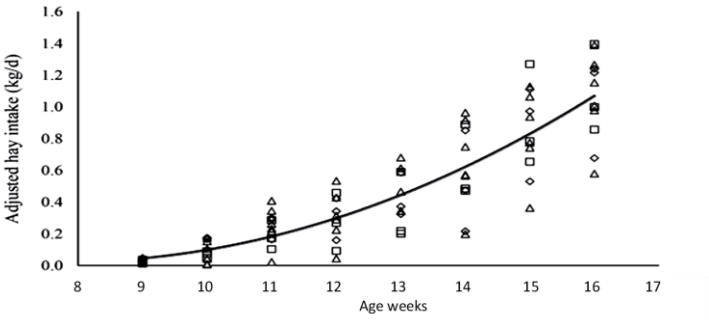


*Figure 7. Relationship between adjusted ad libitum hay intake and age of calf when calves were fed calf starter and forage. Adapted from: Aragona et al., 2020.*

Ad libitum hay intakes in Figures 4 and 7 are far lower than those recommended by EFSA. For example, at 12 weeks of age, calves consumed about 250 g/d (Figure 4) or 300 g/d (Figure 7) of forage, which is far lower than the 1.66 kg/d recommended by EFSA. This may be because calves in these studies were offered concentrates in addition to ad libitum forage.

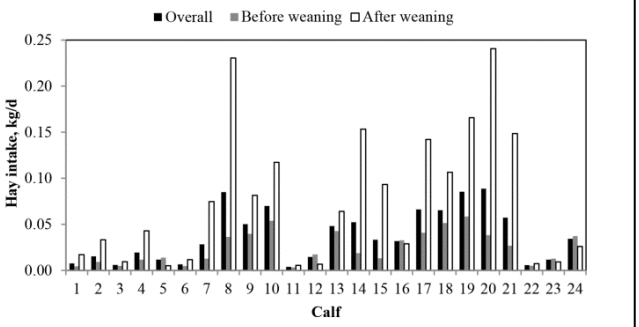


*Figure 8. Intake of hay by individual calves for pre-weaning, post-weaning, and overall periods. From Hill et al. (2019).*

When calves are offered forage and concentrates for ad libitum consumption in combination with calf milk replacer, the intake of forage is highly variable, as shown in Figure 8 from Hill et al. (2019). It's clear that many calves consumed little or no long forage throughout the 56-day experiment. Overall, calves consumed 6% of their total dry matter as forage. This is similar to data from Castells et al. (2012), who reported that calves offered ad libitum oat hay, barley straw, or ryegrass hay consumed 8%, 5%, and 4% of total dry feed intake as forage, respectively. Finally, when we calculate the voluntary forage intake from data of Xiao et al. (2023), the % of total dry feed intake as forage was 10%, 11%, and 11% for calves offered forage beginning on d 5, 8 or 12, respectively. Data from Figure 5 suggests that veal calves consume a greater proportion (30-40%) of their dry feed as forage, which is somewhat higher than values for replacement calves. In total, however, all these data suggest that when calves have their choice, they consume a diet mainly of concentrate and not forage. The amounts recommended by EFSA are far in excess of what calves seem to prefer.

Bottom line: ***Forage and NDF intakes recommended by EFSA have no clear basis when we consider the biology and nutrition of the calf. Calves are unlikely to consume the forage recommended, and if***

***they did, their growth would be significantly and irreparably impaired with negative effects on welfare and production.***

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